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**THE GROWTH OF HIGH-TECH COMPANIES: THEORETICAL
FRAMEWORK AND EMPIRICAL RESEARCH**

DOCTORAL DISSERTATION

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POVZETEK

Managerji in podjetniki smatrajo rast podjetja za merilo uspeha. Visokotehnološka podjetja iz IKT-panog (e.g. Google, Uber) dosegajo izredno visoke stopnje rasti. Snovalci vladnih ekonomskih ukrepov jo potrebujejo za doseganje večje zaposlenosti, raziskovalci s področij strateškega managementa in podjetništva pa jo že od začetkov managementa kot znanstvene discipline poskušajo pojasniti.

V prvem poglavju želim ustvariti referenco in priporočila za raziskovalce, ki nameravajo uporabiti bibliometrične metode v pregledih literature na področju managementa in organizacije. Take metode povečajo objektivnost v pregledih literature in lahko tudi omejijo pristranskost raziskovalcev, ki pregledujejo literaturo. Z bibliometričnimi metodami je mogoče povzeti in vizualizirati znanstvena področja. Hkrati predstavim priporočila in razvijem postopek uporabe teh metod za povzemanje literature (analiza sklicev, analiza soksliccev, bibliografska sklopljenost, analiza soavtorstva in druge), saj bodo v prihodnosti, poleg metaanalize in strukturiranega literarnega povzetka, postale ena od treh glavnih metod za povzemanje znanstvene literature na področju managementa in organizacije.

Postopek in priporočila za uporabo bibliometričnih metod, ki jih razvijem v prvem poglavju, uporabim v drugem poglavju. Z bibliometrično metodo analize sklicev in analize soksliccev identificiram teoretične temelje rasti podjetij. Ugotovim, da razlage na podlagi teorije virov najpogosteje uporabljajo v sodobnih znanstvenih raziskavah rasti podjetij. Identificiram deset skupin teoretičnih temeljev. Dominantni dve sta: (1) strateško podjetništvo, tesno povezano s teorijo virov in sorodnimi teorijami, in (2) ekonomski temelji, ki so večinoma empirični in ateoretični. Preostalih osem skupin je odraz raznolikosti in fragmentacije raziskovalnega področja. Iz rezultatov analize razvijem raziskovalni program, ki bo koristil prihodnjim raziskavam. Glavni skupini teoretičnih temeljev sta za zdaj precej nepovezani. Večja integracija bi koristila raziskavam iz obeh skupin.

Kritiki znanstvene literature o ovirah pri rasti izpostavljajo nerazvitost in prešibko teoretično utemeljenost. V tretjem poglavju natančno definiram ovire pri rasti kot faktorje znotraj podjetja, ki so potrebni pogoji za rast. Identificiram pet ovir za rast: finance, človeški kapital, ambicije po rasti, znanje o managementu rasti in ujemanje produkta in trga. Logika potrebnih pogojev zahteva, da mora biti, če podjetje želi hitro rasti skozi daljše obdobje, izpolnjenih vseh pet pogojev. Ugotovitve temeljijo na dvaintridesetih intervjujih s tehnološkimi podjetniki, svetovalci in predstavniki podpornega okolja, podatkih iz trimesečnega opazovanja generacije visokotehnoloških startupov v podjetniškem pospeševalniku in obstoječi znanstveni literaturi. Ovire pri rasti postavim v okvir Spiglovega (2015) modela podjetniškega ekosistema in natančno določim, kako faktorji na nivoju podjetniškega ekosistema vplivajo na ovire pri rasti na nivoju podjetja.

Ključne besede: rast podjetja, ovire za rast, hitrorastoča podjetja, bibliometrične metode

SUMMARY

Researchers from the fields of strategic management and entrepreneurship have been seeking to explain firm growth since the foundation of management as a scientific discipline. Managers and entrepreneurs see growth as a measure of success. Policymakers need growth to provide new jobs. High-tech firms from the ICT sector (e.g. Google, Uber) have been able to grow at extremely high rates. The purpose of my dissertation is to contribute to knowledge on the growth of high-tech firms.

In the first chapter, I aim to develop a meaningful single-source reference for management and organization scholars interested in using bibliometric methods for mapping research specialties. Such methods introduce a measure of objectivity into the evaluation of scientific literature and hold the potential to increase rigor and mitigate researcher bias in reviews of scientific literature by aggregating the opinions of multiple scholars working in the field. I introduce the bibliometric methods of citation analysis, co-citation analysis, bibliographical coupling, co-author analysis, and co-word analysis and present a workflow for conducting bibliometric studies with guidelines for researchers. I envision that bibliometric methods will complement meta-analyses and qualitative structured literature reviews as a method for reviewing and evaluating scientific literature.

The process and guidelines developed in the first chapter are used to conduct a bibliometric study in the second chapter. I employ the bibliometric methods of citation and co-citation analysis to identify the theoretical foundations of firm growth. I show that resource-based explanations of growth dominate contemporary research. I identify ten distinctive groups of theoretical foundations. The most dominant two are: (1) strategic entrepreneurship, closely associated with the resource-based and related perspectives; and (2) economics, which is largely empirical and atheoretical. The remaining eight groups manifest the diversity and fragmentation of the firm growth research. Drawing on my findings, I outline a research program to take the field forward and suggest that the two major research streams would benefit from greater integration.

The barriers to growth literature has been criticized for being underdeveloped and undertheorized. In the third chapter, I conceptualize barriers to growth as firm-level factors that are necessary conditions for growth. There are five barriers to growth: finance, human capital, growth ambition, growth management knowledge, and product-market fit. The necessary conditions logic demands that all conditions must be fulfilled if a firm is to persistently grow. The conceptualization is based on 32 interviews with technology entrepreneurs, investors and support-institution representatives, data from a three-month observation of a batch of high-tech startups in a venture accelerator, and the existing literature. I contextualize barriers in Spigel's (2015) model of an entrepreneurial ecosystem by specifying how the ecosystem level conditions influence barriers on the firm level.

Keywords: firm growth, barriers to growth, high-growth firms, bibliometric methods

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INTRODUCTION

Description of the dissertation topic and the issues it addresses

Ever since Edith Penrose (1959) theorized that a firm's resources directly influence its growth, the growth phenomenon has been of particular interest to researchers in management. Firm growth is a relevant and important topic of management research and has attracted considerable academic interest (e.g. Delmar, Davidsson, & Gartner, 2003; McKelvie & Wiklund, 2010; Wright & Stigliani, 2013). In addition, the phenomenon of firm growth has attracted the attention of policymakers ever since Birch's groundbreaking (1987) research on the topic. He asserted that a handful of fast-growing smaller firms had become a fountainhead of job creation and the economic recovery of the U.S. economy. The idea that these smaller growing firms, often referred to as gazelles (Henrekson & Johansson, 2010), should be the target of policymaking efforts is generally accepted knowledge in policymaking discourse (Mason & Brown, 2011; Shane, 2009). Further, this idea remains alive in the present, where it is mostly found in policy reports emphasizing a significant focus on high-growth firms (Mitusch & Schimke, 2011; OECD, 2013). The idea of firm growth is certainly appealing to entrepreneurs and their investors as an early sign of the future profit returns a growing firm may create.

Questions citing specific psychological characteristics of entrepreneurs (e.g. Smith, Baum, & Locke, 2001), industry characteristics (e.g. Evans, 1987), alliances (e.g. Stuart, 2000), and available resources (e.g. Cooper, Gimeno-Gascon, & Woo, 1994) impact the pace and mode of firm growth and remain in the prime research limelight. By analyzing the antecedents to firm growth, researchers have tried to explain why some firms grow faster than others, while also examining how firm growth contributes to ultimate organizational success (Davidsson, Steffens, & Fitzsimmons, 2009).

Due to the vitality and dynamism of firm-growth research, several authors have produced exceptional studies integrating otherwise disparate literature on firm growth (Coad, 2009; Davidsson, Achtenhagen, & Naldi, 2010; Gilbert, McDougall, & Audretsch, 2006; Henrekson & Johansson, 2010; Levie & Lichtenstein, 2010; McKelvie & Wiklund, 2010). Nevertheless, cumulative findings from an existing review of studies on firm growth suggest that: (a) there is still little consensus on what firm growth actually is – researchers continue to question whether firm growth is an outcome of a process or an intermediary stage in the development process of a firm; (b) the degree to which different antecedents contribute to firm growth; (c) the role of modes of growth is unclear; and (d) the identifiable growth stages and transitions remain ambiguous. Such gaps in our current knowledge on firm growth can be attributed to the divergence in theoretical and epistemological perspectives on growth and their corresponding review studies. A rigorous analysis of the intellectual structure of the

body of literature on firm growth is needed in order to unveil the theoretical foundations of this stream of research.

Barriers to growth are factors that limit growth in new ventures. Although barriers can be viewed as the mirror image of drivers of growth, some factors are more frequently discussed as constraints and limiters on growth (Davidsson et al., 2010). Several studies found that financial constraints are the most common impediment to growth (Pissarides, 1999). Institutional barriers like taxation and regulation are often considered an important impediment to growth. Andersson (2003) found that rules and taxation make it hard to attract foreign talent to Sweden. Budak and Rajh (2014) examined how the business sector is dealing with corruption in seven Western Balkan countries. They found that some entrepreneurs understand corruption as ‘greasing the wheels’ and that a key component of fighting corruption would be raising anti-corruption awareness. Interestingly, some studies reported (Xheneti & Bartlett, 2012) that firms which were more aware of corruption grew faster. Aidis (2005) conducted a study on 332 Lithuanian SMEs and found that formal and informal barriers are interrelated.

A large amount of research on barriers to growth is geographically focused on Eastern European transitional countries. Barriers to growth have been researched in Lithuania (Aidis, 2005), Albania (Hashi, 2001; Xheneti & Bartlett, 2012), Kosovo (Hoxha & Capelleras, 2010), Slovenia (Bartlett & Bukvič, 2001), Russia (Rachel Doern, 2009) and Bulgaria (Pissarides, Singer, & Svejnar, 2003). Another focus has been on developing countries (Coad & Tamvada, 2012; Das & Das, 2014; Robson & Obeng, 2008) or specific contexts in developed countries (e.g. Lee & Cowling, 2013). However, the barriers to growth literature is fragmented and theoretically underdeveloped (Rachel Doern, 2009). Existing studies are based on quantitative surveys with theoretically weakly founded questionnaires. A shift from prediction towards understanding is needed, which makes qualitative methods more appropriate.

The ICT sector is known for being highly dynamic, competitive, and turbulent. Digital companies are capable of extremely fast growth. Companies founded less than 20 years ago are today among the largest in the world by revenue (e.g., Facebook, Google). Constant development, technological change, short product life cycles and the great importance of economic forces like network effects, lock-in, and increasing returns of scale are characteristics of the environment which managers of high-tech firms must acknowledge. The business environment of high-tech ICT companies is therefore specific and worthy of special examination.

Purpose, research goals, research questions and research methods

The purpose of this dissertation is to contribute to knowledge about firm growth, particularly in the context of high-tech firms in the ICT sector. This context is crucial for modern economic performance and technological progress. The newly created knowledge should help entrepreneurs better manage the growth of their firms and assist policymakers in designing policies targeting high-growth firms.

In the following sections, I present the research goals, research questions, and research methods separately for each of the three main chapters of the dissertation.

Chapter 1 – Bibliometric methods in management and organization

Even though the chief purpose of this dissertation is to contribute to explaining the growth of high-tech companies, the first chapter is methodological. My initial intention was to start the dissertation with a thorough bibliometric examination of the theoretical foundations of firm growth. However, when surveying the literature on implementing bibliometric methods I found that the recommendations are scattered across the literature and there is no single source reference to use when conducting bibliometric reviews of literature. This realization led me to the research goal of the first chapter.

RG1: To develop guidelines for conducting bibliometric reviews of scientific literature.

Achieving this goal involved two steps. Initially, I had to take stock of what had already been done with bibliometric methods in management research and how the methods were used by researchers. Then I needed to use the available information (from both studies that used bibliometric methods, and literature that was developing and testing the methods) to develop guidelines embodied in an appropriate procedure. The two research questions tied to the first research goal are thus the following.

RQ1a: How are bibliometric methods used for the purpose of literature reviews in the management and organization field?

RQ1b: What is the appropriate procedure for using bibliometric methods in literature reviews?

Answering the first research question (RQ1a) primarily entailed the method of review. First, I systematically searched for and selected all published bibliometric studies in the management literature. Then I coded the studies according to predetermined categories (e.g., the method used, data source, software used). The studies were then also coded by another researcher to increase the accuracy. Differences between the codes were reconciled.

Answering the second question (RQ1b) required a synthesis of the findings of the review of published bibliometric studies with methodological literature on bibliometric methods. The result of this was a set of recommendations for using bibliometric methods, which I systematized in a five-step process.

Chapter 2 – Theoretical foundations of firm growth

Previous reviews of firm growth literature (e.g., Davidsson et al., 2010; Shepherd & Wiklund, 2009) identified several methodological and conceptual problems that have been plaguing research. However, there is very little explicit discussion and even less quantitative evidence concerning which theories are actually used in firm growth research. This fact led me to the research goal of the second chapter.

RG2: To quantitatively establish the theoretical foundations of the firm growth literature.

I was interested in two aspects of the theoretical foundations of firm growth: which are the main theories in the firm growth research, and what is the structure of the research. However, the biggest theoretical question was in fact whether the progress of the research is constrained by the use of inappropriate theories. Therefore, the three research questions linked to the second research goal are:

RQ2a: What are the theoretical foundations of the firm growth research?

RQ2b: What is the intellectual structure of the firm growth research?

RQ2c: Is scientific progress in understanding firm growth hindered by the use of inappropriate theories?

The guidelines for conducting bibliometric reviews I developed in the first chapter formed the methodological basis for the second chapter. The main theories in firm growth research (RQ2a) were identified with the method of citation analysis. This method uses citations as a measure of influence and is thus able to determine which documents are the most influential in extant research. The structure of the firm growth research (RQ2b) was examined with co-citation analysis and visualized with network analysis. Finally, the findings of the previous two research questions were synthesized with the findings of earlier firm growth reviews to establish whether the theories used are constraining the progress of research (RQ2c).

Chapter 3 – Barriers to the growth of high-tech firms

Barriers to growth are usually viewed as factors that constrain firm growth. These factors have been extensively researched in the transitional environments of Central and Eastern

Europe, yet there is almost no research on the barriers to the growth of high-tech firms. This problem led me to the research goal of the third chapter.

RQ3: To theoretically and empirically establish how barriers to growth constrain the growth of high-tech companies.

Thorough examinations of the barriers to growth research have established that the concept is inadequately theorized and that the definitions of barriers are problematic (Rachel Doern, 2009). This means that, before determining how barriers limit the growth of high-tech companies, I needed to establish whether the barriers are appropriately conceptualized and, if not, to develop a new conceptualization. The three research questions associated with the third research goal then are:

RQ3a: Are barriers to growth appropriately conceptualized?

RQ3b: If necessary, develop the concept of barriers to growth.

RQ3c: How do barriers to growth prevent the faster growth of high-tech companies?

I used the method of literature review to examine the definitions of barriers offered in previous studies (RQ3a). It quickly turned out that the majority of studies did not even define what barriers are. It then became necessary to properly develop the concept of barriers to growth (RQ3b) while simultaneously determining how the barriers constrain firm growth in a high-tech context (RQ3c). I collected and analyzed the data using grounded theory principles (theoretical sampling, coding, iteration between theory and data, theoretical saturation) (Glaser & Strauss, 1967; O'Reilly, Paper, & Marx, 2012). I primarily used semi-structured interviews and direct observation as methods for collecting the data. Finally, I developed a new conceptualization of barriers to growth based on recommendations to better develop the concept (Podsakoff, MacKenzie, & Podsakoff, 2016).

Summary

Table 1. Overview of research goals, research questions and research methods

Chapter	Research goal	Research questions	Research methods
1 – Bibliometric methods in management and organization	RG1: To develop guidelines for conducting bibliometric reviews of scientific literature.	RQ1a: How are bibliometric methods used for the purpose of literature reviews in the management and organization field? RQ1b: What is the appropriate procedure for using bibliometric methods in literature reviews?	Review Synthesis
2 – Theoretical foundations of firm growth	RG2: To quantitatively establish the theoretical foundations of the firm growth literature.	RQ2a: What are the theoretical foundations of the firm growth research? RQ2b: What is the intellectual structure of the firm growth research? RQ2c: Is scientific progress in understanding firm growth hindered by the use of inappropriate theories?	Citation analysis Co-citation analysis Network analysis Synthesis
3 – Barriers to the growth of high-tech firms	RG3: To theoretically and empirically establish how barriers to growth limit the growth of high-tech companies.	RQ3a: Are barriers to growth appropriately conceptualized? RQ3b: If necessary, develop the concept of barriers to growth. RQ3c: How do the barriers to growth prevent the faster growth of high-tech companies?	Literature review Semi-structured interviews Direct observation Grounded theory building Concept development

Structure of the dissertation

This doctoral dissertation is divided into an introduction, three main chapters, and a conclusion. The introduction briefly presents the theoretical background, purpose, research goals, and research methods of the dissertation. Chapter 1 focuses on bibliometric methods in management and organization. It reviews the use of bibliometric methods in the management field and develops the procedure and guidelines for using bibliometric methods to conduct literature reviews. Chapter 2 uses the procedure developed in Chapter 1 to quantitatively establish the theoretical foundations and intellectual structure of the firm growth research. Chapter 3 develops the conceptualization of barriers to growth from qualitative data and the existing literature. It empirically examines the barriers to growth in high-tech companies in the ICT sector. The conclusion summarizes the main findings and biggest contributions of the previous three chapters. It also states the research limitations and directions for further research. References are included after the conclusion. These are followed by appendices, the last of which is an extended summary of the dissertation in the Slovenian language.

1 BIBLIOMETRIC METHODS IN MANAGEMENT AND ORGANIZATION

We aim to develop a meaningful single-source reference for management and organization scholars interested in using bibliometric methods for mapping research specialties. Such methods introduce a measure of objectivity into the evaluation of scientific literature and hold the potential to increase rigor and mitigate researcher bias in reviews of scientific literature by aggregating the opinions of multiple scholars working in the field. We introduce the bibliometric methods of citation analysis, co-citation analysis, bibliographical coupling, co-author analysis, and co-word analysis and present a workflow for conducting bibliometric studies with guidelines for researchers. We envision that bibliometric methods will complement meta-analysis and qualitative structured literature reviews as a method for reviewing and evaluating scientific literature. To demonstrate bibliometric methods, we performed a citation and co-citation analysis to map the intellectual structure of the *Organizational Research Methods* journal.

1.1 Introduction

Synthesizing past research findings is one of the most important tasks for advancing a particular line of research. Scholars have traditionally used two methods to make sense of earlier findings: the qualitative approach of a structured literature review, and the quantitative approach of meta-analysis (Schmidt, 2008). We introduce a third method – science mapping – which is based on the quantitative approach of bibliometric research methods and is being increasingly used to map the structure and development of scientific fields and disciplines.

Science mapping uses bibliometric methods to examine how disciplines, fields, specialties, and individual papers are related to one another. It produces a spatial representation of the findings analogous to geographic maps (Calero-Medina & van Leeuwen, 2012; Small, 1999). Science mapping is a combination of classification and visualization (Boyack & Klavans, 2013). The aim is to create a representation of the research area's structure by partitioning elements (documents, authors, journals, words) into different groups. Visualization is then used to create a visual representation of the classification that emerges.

Narrative literature reviews are subjected to bias by the researcher and often lack rigor (Tranfield, Denyer, & Smart, 2003). Bibliometric methods employ a quantitative approach for the description, evaluation and monitoring of published research. These methods have the potential to introduce a systematic, transparent and reproducible review process and thus improve the quality of reviews. Bibliometric methods are a useful aid in literature reviews even before reading begins by guiding the researcher to the most influential works and mapping the research field without subjective bias.

Although bibliometric methods are not new (c.f. Kessler, 1963; Small, 1973), they only started to attract widespread attention with the proliferation of easily accessible online databases with citation data (e.g. Thomson Reuters Web of Science (WOS), which contains SSCI and SCI data) and the development of software for conducting bibliometric analyses (e.g. BibExcel). Bibliometric methods have been used to map the fields of strategic management (e.g. Di Stefano, Verona, & Peteraf, 2010; Nerur, Rasheed, & Natarajan, 2008; Ramos-Rodriguez & Ruiz-Navarro, 2004), entrepreneurship (e.g. Gartner, Davidsson, & Zahra, 2006; Landström, Harirchi, & Åström, 2012; Schildt, Zahra, & Sillanpaa, 2006), innovation (e.g. Fagerberg, Fosaas, & Sapprasert, 2012; Fagerberg & Verspagen, 2009) and others (see Appendix A for a full list of studies published in management and organization). Some research fields (e.g. innovation, entrepreneurship, strategy) have more rapidly embraced bibliometric methods, while others (e.g. organizational behavior, psychology) have been slower. We believe this is because the knowledge base of the former is closer to bibliometric methods and that this represents a big opportunity for researchers working in those fields that have yet to start publishing bibliometric studies.

Bibliometric methods allow researchers to base their findings on aggregated bibliographic data produced by other scientists working in the field who express their opinions through citation, collaboration, and writing. When this data is aggregated and analyzed, insights into the field's structure, social networks and topical interests can be put forward. The use of bibliometric analysis is growing rapidly. The median year of publication of bibliometric studies in management and organization is 2011, meaning that over half the articles were published in the last three years. The authors' anecdotal experience also suggests that management scholars are becoming ever more interested in using bibliometric methods to supplement the subjective evaluation of literature reviews. Notwithstanding this growing interest, there are hardly any guidelines for conducting structured literature reviews with bibliometric methods.

The purpose of this chapter is to develop a meaningful single-source reference for management and organization scholars interested in bibliometric methods. The chapter's main contribution is the development of recommended workflow guidelines for carrying out bibliometric studies. We synthesized the guidelines from 81 bibliometric studies in management and organization (details about the selection and a full study list are available in Appendix A) and bibliometric methodology literature. We demonstrated the use of these guidelines by performing a bibliometric analysis of the *Organizational Research Methods* journal. Given that the use of bibliometric methods is on the rise and there is a dearth of guidance on how to use these methods, this chapter may provide a valuable reference for scholars interested in bibliometric methods.

1.2 Bibliometric methods

Almost five decades ago, Derek J. de Solla Price (1965) proposed scientific methods of science for studying science (Boyack, Klavans, & Börner, 2005). Bibliometric methods (e.g. co-citation

analysis, bibliographic coupling) use bibliographic data from publication databases to construct structural images of scientific fields. They introduce a measure of objectivity into the evaluation of scientific literature (Garfield, 1979) and can be used to detect informal research networks, i.e. “invisible colleges”, which exist under the surface but are not formally linked (Crane, 1972; Price, 1965). These groups share research interests and have underlying contacts through personal communication, conferences, summer schools that are invisible to the outsider. Citation images of research fields, aggregated through time, reflect authors’ judgments on the subject matter, methodology and the value of other writers’ work (White & McCain, 1998).

Bibliometric methods have two main uses: performance analysis and science mapping (Cobo, López-Herrera, Herrera-Viedma, & Herrera, 2011). Performance analysis seeks to evaluate the research and publication performance of individuals and institutions. Science mapping aims to reveal the structure and dynamics of scientific fields. This information about structure and development is useful when the researcher’s aim is to review a particular line of research. Bibliometric methods introduce quantitative rigor into the subjective evaluation of literature. They are able to provide evidence of theoretically derived categories in a review article.

In the following section we will introduce the five main bibliometric methods. The first three use citation data to construct measures of influence and similarity: citation analysis, co-citation analysis, and bibliographical coupling. Co-author analysis uses co-authorship data to measure collaboration. Co-word analysis finds connections among concepts that co-occur in document titles, keywords or abstracts. A summary of bibliometric methods with their strengths and weaknesses is provided in Table 2.

Table 2. Summary of bibliometric methods

Method	Description	Units of analysis	Pros	Cons
Citation	Estimates influence of documents, authors or journals through citation rates.	document author journal	Can quickly find the important works in the field.	Newer publications had less time to be cited, therefore citation count as a measure of influence is biased towards older publications.
Co-citation	Connects documents, authors or journals on the basis of joint appearances in reference lists.	document author journal	It is the most used and validated bibliometric method. Connecting documents, authors or journals with co-citation has been shown to be reliable. Since citation is a measure of influence it offers a method to filter the most important works.	Co-citation is performed on cited articles so it is not optimal for mapping research fronts. Citations take time to accumulate so new publications cannot be connected directly but only through knowledge base clusters. Several citations are needed to map articles so it is impossible to map articles which are not cited much. When performing author co-citation analysis on SSCI (WOS) data, only first-author information is available.
Bib. Coupling	Connects documents, authors or journals on the basis of the number of shared references.	document author journal	Immediately available: does not require citations to accumulate. Can be used for new publications which are not cited yet, emerging fields and smaller subfields.	It can only be used for limited timeframe (up to a five-year interval). It does not inherently identify the most important works by citation counts as co-citation; it is difficult to know whether mapped publications are important or not.
Co-author	Connects authors when they co-author the paper.	author	Can provide evidence of collaboration and produce the social structure of the field.	Collaboration is not always acknowledged with co-authorship.
Co-word	Connects keywords when they appear in the same title, abstract or keyword list.	word	It uses the actual content of documents for analysis (other methods only use bibliographic meta-data).	Words can appear in different forms and can have different meanings.

Most bibliometric studies provide a **citation analysis** of the research field, usually in the form of top-N lists of the most cited studies, authors or journals in the examined area. Citations are used as a measure of influence. If an article is heavily cited, it is considered important. This proposition rests on the assumption that authors cite documents they consider to be important for their work. Citation analysis can provide information about the relative influence of the publications, but it lacks the ability to identify networks of interconnections among scholars (Usdiken & Pasadeos, 1995).

Co-citation analysis (McCain, 1990) uses co-citation counts to construct measures of similarity between documents, authors or journals. Co-citation is defined as the frequency with which two units are cited together (Small, 1973). A fundamental assumption of co-citation analysis is that the more two items are cited together, the more likely it is that their content is related. Different types of co-citation can be utilized, depending on the unit of analysis: document co-citation analysis, author co-citation analysis (McCain, 1990; White & Griffith, 1981; White & McCain, 1998), and journal co-citation analysis (McCain, 1991). Co-citation connects documents, authors or journals according to the way writers use them. This is a rigorous grouping principle repeatedly performed by subject-matter experts who cite publications they deem valuable and/or interesting. Because the publication process is time-consuming, the co-citation image reflects the state of the field sometime before, not necessarily how it looks now or how it may look tomorrow. It is a dynamic measure that changes through time. When examined over time, co-citations are also helpful in detecting a shift in paradigms and schools of thought (Pasadeos, Phelps, & Kim, 1998).

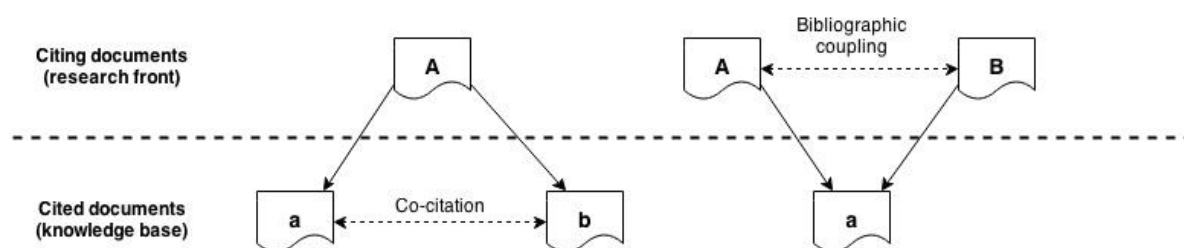
Document co-citation analysis connects specific published documents (research articles, books, editorials or other published material). Author co-citation analysis (ACA) connects bodies of writings by a person and therefore the authors who produced them (White & Griffith, 1981). ACA can identify important authors and connect them through citation records (White & McCain, 1998). What is mapped is an author's citation image. Journal co-citation analysis (JCA) aims to connect related scientific journals.

A special form of co-citation is tri-citation analysis (Marion, 2002; McCain, 2009; McCain & McCain, 2002), which examines the »intellectual fellow travelers« of a particular author or publication by analyzing works which have been co-cited with them. It has the potential for researching the legacy of important authors or seminal studies. Tri-citation is a variant of co-citation analysis where the focal author or publication is always one of the cited publications and provides the context for co-citation analysis. For instance, the seminal paper on absorptive capacity (Cohen & Levinthal, 1990) is one of the most influential papers in strategy and innovation. To examine the context of its influence, one could produce a tri-citation analysis to connect all pairs of publications that are cited with Cohen & Levinthal

(1990). This method could be especially appropriate for special issues which celebrate anniversaries of important publications or are published in honor of important authors.

Although **bibliographic coupling** (Kessler, 1963) is a decade older than co-citation (Small, 1973), co-citation has been more frequently used for mapping science (D. Zhao & Strotmann, 2008). Bibliographic coupling uses the number of references shared by two documents as a measure of the similarity between them. The more the bibliographies of two articles overlap, the stronger their connection. The difference between co-citation analysis and bibliographic coupling is visually presented in Figure 1.

Figure 1. Co-citation analysis and bibliographic coupling (adapted from Vogel & Güttel, 2013).



The number of references shared between two documents is static over time (i.e. for the relationship between two documents it does not matter when the analysis is conducted) as the number of references within the article is unchanged, while relatedness based on co-citation develops with citation patterns. As citation habits change, bibliographic coupling is best performed within a limited timeframe (Glänzel & Thijs, 2012). It is best to analyze publications from roughly the same period of time (i.e. it makes no sense to couple a publication issued in 1964 with a publication issued in 2012). A bibliographic coupling connection is established by the authors of the articles in focus, whereas a co-citation connection is established by the authors who are citing the examined works.

When two documents are highly co-cited this means that each individual document is also highly individually cited (Jarneving, 2005). This indicates that documents selected through co-citation thresholds are deemed more important by the researchers who are citing them. Yet the bibliographic coupling measure cannot be used in such a way, so identifying which documents are more important than others is a challenge when undertaking bibliographic coupling. However, this is also a weakness of co-citation analysis: it carries more information for highly cited documents, but is much less reliable for clustering smaller niche specialties which are formed by less cited documents.

The choice of which method to employ depends on the goals of the analysis. To map a current research front, bibliographic coupling might be used while, to map older papers, co-citation could be better choice (Small, 1999). The latest studies show that the accuracy of

bibliographic coupling in representing a research front is better than that of a co-citation analysis (Boyack & Klavans, 2010).

There are several limitations of citation-based bibliometric methods (citation analysis, co-citation analysis, and bibliographical coupling). Based solely on the bibliometric data, it is impossible to establish the reason that a particular publication was cited. Different citations of the same publication can be made for many different reasons. The articles could be citing literature to refute it (negative citations). It is quite possible for bad scientific work to receive more citations than mere mediocre work (Wallin, 2005). However, citations for negative reasons are extremely rare and scientists generally do not criticize previous literature too much (Garfield, 1979). And even then it is not necessarily valid to assume that critics are necessarily right, thus the critiqued literature is likely to contain some merit. Citation-based metrics could be biased due to self-citation in the form of author self-citation (citing publications where one is a co-author) or team self-citation (citing publications authored by one's collaborators). These practices tend to increase citation frequencies and are thus a manipulation, although one would have to publish a tremendous amount to reasonably increase the citation frequencies.

Co-author analysis examines the social networks scientists create by collaborating on scientific articles (Acedo, Barroso, Casanueva, & Galan, 2006). A relationship between two authors is established when they co-publish a paper (Lu & Wolfram, 2012). Co-authoring scientific publications is presumed to be a measure of collaboration. Co-authorship reflects stronger social ties than other relatedness measures, which makes it particularly suitable for examining social networks rather than intellectual structures of research fields. Further, because bibliographic data contains information about authors' institutional affiliations and their geographical location, co-author analysis can examine the issues of collaboration on the level of institutions and countries.

Co-authorship as a measure of collaboration assumes that authoring a publication is synonymous with being responsible for the work done. However, just because a person's name appears as a co-author of a scientific article it is not necessarily because they contributed a significant amount of work, but could be purely "honorary authorship" for social or other reasons (Katz & Martin, 1997). On the other hand, there might be scientists who contributed to the work but whose names do not appear on the author sheet.

Co-word analysis (Callon, Courtial, Turner, & Bauin, 1983) is a content analysis technique that uses the words in documents to establish relationships and build a conceptual structure of the domain. The idea underlying the method is that, when words frequently co-occur in documents, it means that the concepts behind those words are closely related. It is the only method that uses the actual content of the documents to construct a similarity measure, while the others connect documents indirectly through citations or co-authorships. The output of

co-word analysis is a network of themes and their relations which represent the conceptual space of a field. This semantic map helps to understand its cognitive structure (Börner, Chen, & Boyack, 2003). A series of such maps produced for different time periods can trace the changes in this conceptual space (Coulter, Monarch, & Konda, 1998). Co-word analysis can be applied to document titles, keywords, abstracts or full texts. The unit of analysis is a concept, not a document, author or journal.

The quality of results from co-word analysis depends on variety of factors – the quality of keywords, the scope of the database and the sophistication of statistical methods used for analysis (He, 1998). Solely using keywords for co-word analysis is a problem for two reasons. First, many journals' bibliographic data do not contain keywords. Second, relying just on keywords suffers from so-called “indexer effect” – where the validity of the map is dependent on whether the indexers captured all relevant aspects of the text. The solution is to use abstracts or full texts, but this introduces noise into the data as the algorithms have difficulty distinguishing the importance of words in large corpuses of text.

The current bibliometric landscape is dominated by co-citation analysis, which is used in the majority of bibliometric studies in management and organization. Bibliographic coupling is a neglected method with great potential for further use in the management domain. It is only after 2012 that the first three studies in management and organization using bibliographic coupling were published (Hanisch & Wald, 2012; Nosella, Cantarello, & Filippini, 2012; Vogel & Güttel, 2013). The limited use of bibliographical coupling partially stems from historical circumstances (co-citation analysis inventor Henry Small's involvement with the Institute for Scientific Information, which played a key part in the development of bibliometrics) and partly from its own limitations as a method (limitation to short timespans, being unable to use citation threshold filtering). However, it is especially useful for mapping research fronts and emerging fields where citation data does not exist or smaller subfields which are not cited enough to produce reliable connections by co-citation analysis.

Our search found 81 studies that used bibliometric methods in management and organization. Two independent researchers coded and analyzed the studies to determine the methods used, the databases, the software and other characteristics. We describe the details of the selection, coding and list all the studies in Appendix A. The descriptive statistics for coded categories (the methods, databases and software used) are summarized in Table 3.

Table 3. Descriptive statistics of the 81 bibliometric studies published in management and organization.

	No.	%	Sample studies
Bibliometric method			
Citation	54	66.7%	Coombes & Nicholson, 2013; Durisin, Calabretta, & Parmeggiani, 2010; Martin, 2012
Co-citation	59	72.8%	Pilkington & Meredith, 2009; Samiee & Chabowski, 2012; Shafique, 2013
Bib. coupling	3	3.7%	Hanisch & Wald, 2012; Nosella et al., 2012; Vogel & Güttel, 2013
Co-author	6	7.4%	Acedo et al., 2006; Fischbach, Putzke, & Schoder, 2011; Raasch et al., 2013
Co-word	11	13.6%	Benavides-Velasco et al., 2011; Leone, Robinson, Bragge, & Somervuori, 2012; Wallin, 2012
Multiple time periods			
Yes	42	51.9%	Samiee & Chabowski, 2012; Shafique, 2013; Vogel, 2012
No	39	48.1%	Di Stefano et al., 2012; Keupp et al., 2012; Walter & Ribiere, 2013
Selection method			
Journal	41	50.6%	Pilkington & Teichert, 2006; Ramos-Rodriguez & Ruiz-Navarro, 2004; Vogel, 2012
Search	47	58.0%	Chabowski, et al., 2011; Di Stefano, et al., 2012; Pilkington & Lawton, 2013
Qualitative	17	22.2%	Backhaus, Luegger, & Koch, 2011; Keupp, Palmié, & Gassmann, 2012
Other	6	6.2%	Acedo, Barroso & Galan, 2006; Fagerberg, Fosaas, et al., 2012
Database			
SSCI (WOS)	56	69.1%	Chabowski, Samiee, & Hult, 2013; Di Guardo & Harrigan, 2012; Nerur et al., 2008
Scopus	3	3.7%	Gedsri, Kongthon, & Vatananan, 2013; Hanisch & Wald, 2012; Walter & Ribiere, 2013
Other	4	4.9%	Charvet, Cooper, & Gardner, 2008; Gundolf & Filser, 2012; Kraus, 2011
Self-constructed	13	16.0%	Bhupatiraju, et al., 2012; Fagerberg, Fosaas, et al., 2012; Hoffman & Holbrook, 1993
Not reported	5	6.2%	
Bibliometric software			
BibExcel	11	13.6%	Cornelius, Landstrom, & Persson, 2006; Landström et al., 2012; Pilkington & Chai, 2008
Sitkis	6	7.4%	Raghuram, Tuertscher, & Garud, 2010; Schildt et al., 2006
Microsoft Excel	12	14.8%	Kim & McMillan, 2008; Ma & Yu, 2010

Other	3	3.7%	Muñoz-Leiva, Sánchez-Fernández, Liébana-Cabanillas, & Martínez-Fiestas, 2013
Not reported	49	60.5%	
<hr/>			
Unit of analysis			
Document	45	55.6%	Pilkington & Meredith, 2009; Shafique, 2013; Vogel & Güttel, 2013
Author	27	33.3%	Acedo et al., 2006; Landström et al., 2012; Nerur et al., 2008; Raasch et al., 2013
Journal	7	8.6%	Vogel, 2012; Wallin, 2012
<hr/>			
Grouping method			
PCA/Factor analysis	27	33.3%	Reader & Watkins, 2006; Shafique, 2013; Vogel & Güttel, 2013
Clustering	21	25.9%	Di Stefano et al., 2012; Keupp et al., 2012; Samiee & Chabowski, 2012
MDS	14	17.3%	Chabowski et al., 2013; Di Guardo & Harrigan, 2012; Nerur et al., 2008
Network	12	14.8%	Backhaus et al., 2011; Ma, Liang, Yu, & Lee, 2012; Walter & Ribiere, 2013
<hr/>			
Visualization method			
MDS	20	24.7%	Chabowski et al., 2013; Cornelius & Persson, 2006; Shafique, 2013
Network analysis	34	42.0%	Fagerberg, Fosaas, et al., 2012; Pilkington & Meredith, 2009; Vogel & Güttel, 2013
Other	13	16.0%	Herbst, Voeth, & Meister, 2011; Muñoz-Leiva et al., 2013
No visualization	14	17.3%	Casillas & Acedo, 2007; Coombes & Nicholson, 2013; Keupp et al., 2012
<hr/>			
Visualization software			
UCINET	21	25.9%	Pilkington & Chai, 2008; Uysal, 2010; Vogel & Güttel, 2013
Pajek	4	4.9%	Ronda-Pupo & Guerras-Martin, 2012; Landström et al., 2012; Wallin, 2012
Other	6	7.4%	Gerdri et al., 2013; Muñoz-Leiva et al., 2013; Walter & Ribiere, 2013
No visualization	14	17.3%	Casillas & Acedo, 2007; Coombes & Nicholson, 2013; Keupp et al., 2012
Not reported	36	44.4%	

Note: the percentages do not necessarily add up to 100% as studies can use multiple methods or units of analysis.

1.2.1 Bibliometric methods and traditional methods of review

In recent years the volume of scientific research increased dramatically. It is becoming increasingly difficult for researchers to keep track of relevant literature in their field. This fact calls for the use of quantitative bibliometric methods which can handle this wealth of data, filter the important works through estimating their impact and discover the underlying structure of a field. Researchers and especially doctoral students need to be equipped with skills that are able to make sense of this information explosion.

Traditional methods of review and evaluation of scientific literature are meta-analysis and structured literature review. Meta-analysis seeks to synthesize empirical evidence from quantitative studies (Aguinis, Pierce, Bosco, Dalton, & Dalton, 2011). It requires that the researcher chooses studies based on the exact relationships they wish to explore (Raghuram et al., 2010) and aggregates multiple findings on these relationships into one overall finding. This is a very powerful method, but inherently limited in the type and breadth of studies it can analyze. On the other hand, structured literature reviews are able to handle the diversity of studies and methodological approaches. Such reviews can provide in-depth analysis of literature and provide an understanding of contextual issues (Raghuram et al., 2010). However, this process is time consuming so the number of analyzed works is limited and prone to researcher's biases. It is a real possibility that important studies could be excluded.

Science mapping with bibliometric methods offers a different perspective on the field. It can analyze any type of study, as long as connections among studies exist in corpus of analyzed studies. Compared with structured literature review, science mapping has more macro focus and aims to find patterns in the literature as body of work. While traditional literature review provides depth, bibliometric methods can handle a wide breadth of hundreds, even thousands of studies. They can provide graphical description of a research field.

We believe bibliometric methods are not a substitute for but a complement to traditional methods of review. Even when used in an ad-hoc manner, they can provide useful information about the research field to the researcher: which are the important publications, authors, what is the structure of the field. Bibliometric methods can be used in standalone bibliometric analysis articles or can provide additional information for use in structured literature reviews.

Bibliometric methods, when used correctly, can provide increased objectivity in literature reviews. They enable the researcher to look behind the scenes and base their opinions on the aggregated opinions of the scholars working in the field. Bibliometrics can help journal editors to evaluate past publications, design new policies and make editorial decisions. Additionally, bibliographic data can be used as an input to other quantitative statistical

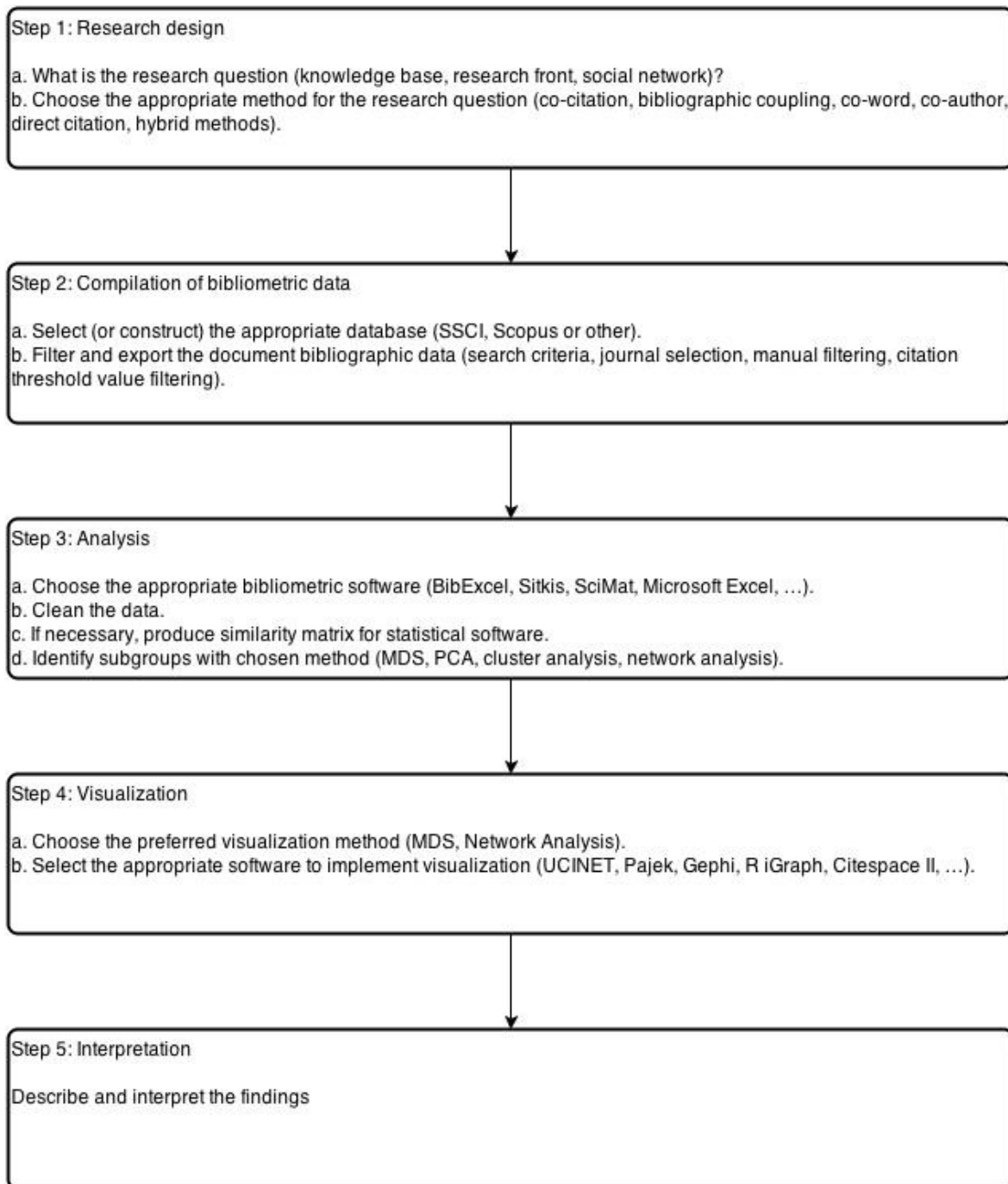
methods which provide further insight and can test hypotheses related to the structure and development of a field.

1.3 Recommended workflow for conducting science mapping studies

Based on the established practices and bibliometric methodology literature, we propose recommended workflow guidelines for science mapping research with bibliometric methods. This is not intended to be a detailed how-to guide, but as an overview of the process with the options (methods, databases, software, etc.) available to scholars and the decisions they have to make at each stage of the research.

The recommended workflow is presented in Figure 2. We delineate a five-step procedure for conducting science mapping in management and organization. First, researchers should define the research question(s) and choose the appropriate bibliometric methods that are able to answer the question(s). Second, researchers need to select the database that contains bibliometric data, filter the core document set and export the data from the selected database. Sometimes this step involves constructing one's own database. Third, bibliometric software is employed for analysis. Alternatively, researchers can write their own computer code to accomplish this step. Results of the bibliometric analysis can be further analyzed with statistical software to identify document subgroups that represent research specialties. Fourth, researchers must decide which visualization method is to be used on the results of the third step and employ appropriate software to prepare the visualization. Finally, the results must be interpreted and described. We have organized the chapter according to these stages of the research process.

Figure 2. Workflow for conducting science mapping with bibliometric methods.



1.3.1 Step 1: Research Design

The first, highly important step in any bibliometric study is to design the research. Researchers need to define the research question and choose an appropriate bibliometric method to answer it. Different bibliometric methods are suitable for answering different research questions. We summarized typical research questions suitable for different bibliometric methods in Table 4.

Table 4. Research questions answered by different bibliometric methods.

Citation analysis

Which authors most influenced the research in a journal?
Which journals and disciplines had the most impact on a research stream?
What is the “balance of trade” between journals/disciplines?
Who are the experts in a given research field?
What is the recommended “reading list” for a specific area?

Co-citation analysis

What is the intellectual structure of literature X?
Who are the central, peripheral or bridging researchers in this field?
How has the diffusion of the concept through research literature taken place?
What is the structure of the scientific community in a particular field?
How has the structure of this field developed over time?

Bibliographical coupling

What is the intellectual structure of recent/emerging literature?
How does the intellectual structure of the research stream reflect the richness of the theoretical approaches?
How has the intellectual structure of small niche X developed through time?

Co-author analysis

Are authors from different disciplinary backgrounds working together on a new research field or do they remain within disciplinary boundaries?
Which factors determine co-authorship?
What is the effect of collaboration on the impact?
Are co-authored articles more cited?
Do more prolific authors collaborate more frequently?
Are internationally co-authored papers more cited?
What is the social structure of the field?

Co-word analysis

What are the dynamics of the conceptual structure of a field?
Uncover the conceptual building blocks of a literature.
What are the topics associated with a particular line of research?
Track the evolution of concept X.

Citation is primarily a measure of impact so the major ability of citation analysis is to find the documents, authors, and journals that are the most influential in a particular research stream. Co-citation analysis and bibliographical coupling use citation practices to connect documents, authors or journals. As such, they are ideally suitable for answering structural questions about research fields.

Since co-citation is applied to the cited articles, it is capable of identifying the knowledge base of a topic/research field and its intellectual structure. The **knowledge base** of a field is the set of articles most cited by the current research. This is sometimes also referred to as the “intellectual base” (Persson, 1994). The structure of the knowledge base is called the **intellectual structure** and refers to the examined scientific domain’s research traditions, their disciplinary composition, influential research topics and the pattern of their interrelationships (Shafique, 2013). These publications are the foundations upon which current research is being carried out and contain fundamental theories, breakthrough early works and methodological canons of the field.

The concept of **research front** was introduced by Price (1965) and is used to describe current scientific papers that cite the publications in the knowledge base. At any given time, these papers are recently published papers that represent the state of the art of a scientific field. Examining the research front of a topic or research field is a task particularly suitable for bibliographical coupling since this method uses reference lists for coupling and does not require the documents to be cited in order to connect them. It is performed on citing publications as opposed to co-citation analysis, which is performed on cited publications. Most of the bibliometric studies in management and organization examine the knowledge base while there is a distinct lack of research front analysis. This could be attributed to the popularity of co-citation and represents an opportunity for the use of bibliographical coupling.

Boyack & Klavans (2010; p. 2391) differentiate between co-citation clustering and co-citation analysis. Co-citation clustering is simply the formation of clusters of cited documents, while co-citation analysis requires the additional step of assigning the research front papers to co-citation clusters. This latest step is most often not performed in bibliometric studies. One of the problems with co-citation clustering is that the analyzed set of documents (co-cited documents) is not the same as the starting set of documents (core documents). Consequently, co-citation clustering is more appropriate for studying the intellectual foundations of research than for evaluating the current research frontier. Publications in co-citation clusters can be connected to the research front publications that are citing them. Unfortunately, most bibliometric software does not have this capability so it has to be done manually. One way to do this is to import bibliometric data into a relational database and find the research front publications that are responsible for co-citation links in

each cluster through search queries. Co-citation can be used to examine the research front of a specified domain but, because it requires an intermediate step of matching cited and citing clusters, the resulting research front clusters will contain more noise than when derived from bibliographical coupling.

Co-author analysis is particularly suitable for studying research questions involving scientific collaboration. This method can analyze co-authorship patterns among contributing scientists and produce a social network of the invisible college that makes up the research field. Researchers can combine co-authorship data with citation data to estimate the effect of collaboration on research impact. For instance, Fischbach, Putzke, & Schoder (2011) examined co-authorship networks within the *Electronic Markets* journal to test various hypotheses of how authors' embeddedness in co-authorship networks affects the impact of their research. Establishing an author's disciplinary background can reveal interdisciplinary collaborations. Raasch, Lee, Spaeth, & Herstatt (2013) studied the emergence of open-source innovation research to find that interdisciplinarity decreases when the research field becomes established. Co-word analysis uses the text of the titles, author-designated keywords, abstracts or even full texts to construct a semantic map of the field. This method can be used to discover linkages among subjects in a research field and trace its development (He, 1998).

Science mapping is performed at a specific point in time to represent a static picture of the field at that moment. However, the core document set can be divided into multiple time periods to capture the development of the field over time. Each time period's bibliometric data is analyzed separately and compared to find changes in the field's structure. This longitudinal analysis can reveal how particular groups within an intellectual structure emerge, grow or fade away.

While these are the most basic types of research questions, the authors of bibliometric studies have started to examine more sophisticated variants of questions. Some authors have considered differences in publication and citation practices between authors from different geographical regions, particularly between the North American and European traditions (Cornelius & Persson, 2006; Pilkington & Lawton, 2013; Usdiken & Pasadeos, 1995). Bibliometric methods can uncover influences about which even field experts might be unaware. Researchers often draw on publications from outside the field, but these publications are rarely mentioned in literature reviews (White & McCain, 1998), which are discipline-focused. Therefore, some recent studies tried to reveal the interdisciplinarity of particular research streams (e.g. Bernroider, Pilkington, & Córdoba, 2013; Raasch, Lee, Spaeth, & Herstatt, 2013).

1.3.2 Step 2: Compiling the bibliometric data

One of the crucial decisions authors of science mapping studies must make is how to limit the scope of their study and define which papers should be included in the set of core documents. Two main options for limiting the scope are available. The first is to search for selected keywords. Because not all journals publish keywords, the search should include article titles and abstracts. Special effort should be made to define search terms that accurately represent the examined field. To increase the validity of search terms, consulting a panel of scholars to determine appropriate keywords is a good practice (e.g. Chabowski, Samiee, & Hult, 2013). However, even when search terms are very carefully chosen, a database search usually finds studies that are not within the scope of the review. These unwanted publications influence the results of bibliometric analysis, introduce outliers into the cited publications and reduce the validity of the results. A method to sift out unwanted documents is needed. This can be dealt with by reading abstracts and qualitatively determining which publications returned by the search are within the scope of the review. However, this method has the potential to introduce bias into the results. This bias can be mitigated by (1) defining beforehand the exact criteria used for selection and (2) having at least two researchers independently perform the selection.

The second option is to limit the scope to articles published in a single or in a small number of journals. This selection method is especially appropriate when the goal is to analyze the publications within a single journal or when the publications in selected specialty journals represent a valid representation of the examined research field. Of course, these methods can be combined to perform a keyword search within a limited range of journals and qualitatively select the publications for bibliometric analysis. An interesting variation of selection is the approach introduced by Fagerberg, Landström & Martin (2012) which relies on citations from handbooks from the fields of innovation, entrepreneurship and science studies to define the core set of documents in each field.

When the core document set has been selected, authors often exclusively use documents or journals that exceed some minimum citation threshold for the purpose of selecting only influential publications and limiting the core document set to a manageable size. This is sometimes necessary when bibliographic coupling or co-author analysis are used which perform the analysis on citing publications (i.e. the core document set). If the threshold is established on the number of total citations, newer publications are at a disadvantage so a better practice would be to rank publications on citations per year. While co-word analysis is also performed on citing publications, the unit of analysis is a word, which means that thresholds should be established for word appearance.

Co-citation analysis is performed on cited publications, which can be very numerous. Filtering through citation thresholds is thus also necessary on cited publications for two

reasons: (1) to limit the analyzed set to a manageable size; and (2) to ensure only cited publications that contain enough citation data for analysis are retained. If publications are not cited or are cited just a few times, it is not possible to perform a co-citation analysis so in this case filtering through the total number of citations is appropriate. Establishing the level of citation thresholds is a part of bibliometric analysis that is definitely more art than science. The choice also depends on whether the goal of the researcher is analysis of a wider, more inclusive set of cited publications or of a smaller, more focused selection. If the cited publications are selected too narrowly, some smaller subgroups will not be found.

Bibliographic Databases

The Social Science Citation Index (SSCI), accessible online through Thomson Reuters Web of Science (WOS), is by far the most common source of bibliographic data. It provides data on documents published in the social sciences and the cited references they contain. Bibliographical data for indexed documents including article title, article type, authors, author institutional affiliations, keywords, abstract, number of citations, journal name, publisher name and address, publication year, volume, issue number, and a list of cited references is available for analysis. All journals indexed in SSCI are assigned one or more subject categories (e.g. Economics, Psychology) that can be used for filtering relevant publications. The SSCI was established by the Institute for Scientific Information (ISI) which is now part of Thomson Reuters. However, it is not without its limitations: the scope of journals covered by the SSCI is limited to those with an official impact factor. It takes time for newer journals to be included in the SSCI so it does not contain data from “just launched” publications. The SSCI (WOS) database is the most frequently used database for bibliometric studies in management and organization. It contains enough data to make it suitable for most bibliometric analysis and is already included in most university subscriptions so it is immediately available to researchers working in academic settings.

An alternative source is the Scopus database. Started in 2004 and owned by Elsevier, it is recommended by some bibliometricians as having a wider coverage than the SSCI (SciTech Strategies, 2012). This broader coverage is useful for mapping smaller research areas that would be insufficiently covered by the SSCI (WOS) database. The importing of data from Scopus is supported by the most commonly used bibliometric software packages, but its use is not yet widespread among management and organization scholars as Scopus was employed by only three studies (c.f. Gerdri, Kongthon, & Vatananan, 2013; Hanisch & Wald, 2012; Walter & Ribiere, 2013). An additional advantage of Scopus is that it contains data for all authors in cited references making author-based citation and co-citation analysis more accurate.

Google Scholar has gained prominence among academics since it has become the most widely used tool for searching scientific publications. Google Scholar includes a broader

range of publications than SSCI (WOS) and includes citation data so it is a potentially useful database for bibliometric analysis. However, Google Scholar does not provide a user interface or API (application programming interface) to enable the exporting of a document set with cited references, which would be needed for bibliometric analysis. It would be potentially feasible to write a program that would download the data from Google Scholar, but Google's policy is to not allow automatic downloading so this approach is not stable and bound to be blocked by Google. Due to these shortcomings, Google Scholar currently cannot be easily used for bibliometric analysis.

Some limitations of bibliometric methods are the consequence of the nature of data in bibliographic databases. The cited reference data from the SSCI only contain information about the first authors of cited publications, meaning that the contributions of second and other authors are underestimated. This is especially noticeable in some seminal, highly cited co-authored contributions (e.g. Dan Levinthal is the second author of the highly cited 1990 Cohen & Levinthal absorptive capacity paper, this omission alone is enough to produce a biased list of top cited authors). The SSCI does not cover all scientific literature – some relevant journals are not included. They do not encompass working papers and papers published in open archives like arXiv and SSRN. Important contributions could be missed as a consequence of this insufficient coverage. Another alternative to established online databases is for researchers to construct their own database based on several different sources.

1.3.3 Step 3: Analysis

The analysis begins with preprocessing. To achieve accurate results it is necessary to clean the data. Although most bibliometric data are reliable, cited references sometimes contain multiple versions of the same publication and different spellings of an author's names. Moreover, since authors are usually abbreviated by their surname and first initial, this poses a problem with some very common names (e.g. Lee, Smith) and authors with two first names (e.g. David Bruce Audretsch could appear as both "Audretsch D." and "Audretsch D.B."). Cited journals might also appear in slightly different forms. Books have different editions, which can appear as different citations (e.g. Yin's "Case Study Research: Design and Methods" could appear as Yin 1984, Yin 1994 or even Yin 2009). While the choice of whether to aggregate different editions of books remains for the researcher, different spellings of authors and journals should be corrected when these are the units of analysis. Researchers should aggregate author or journal data under one spelling and eliminate all the others. This is especially important for author and journal co-citation analysis, co-author analysis, and citation analysis. Corrections can be made with more sophisticated tools that allow calculating similarities between text strings or through capabilities of bibliometric software packages.

When performing co-word analysis it is often desirable to reduce various representations of concepts to one form. A stemming algorithm is the procedure that transforms words to their root form. For example, the concept of “innovation” could appear in several forms: innovation (singular), innovations (plural), innovativeness (noun), innovative (adjective)... A stemming algorithm would reduce all these different appearances to the root “innov” which would represent the concept of innovation. As demonstrated here, stemmed words can be difficult to read for humans so replacing the root with the most common full word is advisable.

Bibliometric software

Several software tools are available to facilitate the bibliometric analysis of scientific literature. Bibliometric tools take raw bibliographic data (e.g. an export from Web of Science), perform bibliometric calculations and calculate the similarity matrices between items (documents, authors, journals, words). They have some analytic capabilities, but normally rely on exporting data for statistical and visualization software for further analysis. In this section, we will briefly introduce three bibliometric tools: BibExcel (Persson, Danell, & Wiborg Schneider, 2009), Sitkis (Schildt et al., 2006) and SciMAT (Cobo et al., 2012). BibExcel and Sitkis were the tools most often referenced in bibliometric analyses. Interestingly, several studies report using Microsoft Excel to perform bibliometric calculations.

BibExcel was developed by Olle Persson (Persson et al., 2009) and is the software most used for performing bibliometric analysis in management and organization. Although its user interface cannot be described as being very friendly, it can be learned quickly and is very efficient. BibExcel can perform all bibliometric methods (co-citation, bibliographical coupling, co-author, and co-word analysis) and has many additional features (e.g. word stemmer to aid co-word analysis). Its website contains many tutorials on how to use the software for various bibliometric analyses. Exporting options include co-occurrence matrices for later use in statistical software and network formats that can be used in network analysis packages. BibExcel is easy to learn and very quick to operate. Its main drawbacks are the lack of advanced preprocessing capabilities for data cleaning and its quirky user interface. If the goal of the researcher is to produce quick bibliometric calculations and perform data cleaning and advanced analysis in other programs, BibExcel is the right choice.

Sitkis (Schildt, 2005) was developed by Henri A. Schildt at the Helsinki University of Technology. It is a bibliometric data management tool that can be used for aiding reviews and bibliometric calculations. With Sitkis it is possible to perform basic data preprocessing tasks and perform co-citation and co-author analysis. Data can be exported to tab-delimited Excel-friendly text files that can also be used in UCINET network analysis software. One distinct feature of Sitkis is that it implements a dense network subgrouping algorithm – a

clustering procedure developed especially for bibliometric analysis (Schildt & Mattsson, 2006). The tool is relatively simple to use, but uses legacy technology (Access) for database storage and is no longer being actively developed. The last version of this software dates from 2005. We would thus recommend using this software option predominantly if a researcher already has Sitkis experience.

SciMAT (Cobo et al., 2012) is one of the newer additions to bibliometric software options. Developed by a research group at the University of Granada, SciMAT is software that covers the whole workflow of science mapping from data preprocessing to visualization. It has a better user interface, superior preprocessing capabilities for cleaning the data, and is a more recent and open source. It guides the user through whole workflow, being in this sense more rigid than BibExcel. It is good software for carrying out a thorough science mapping procedure, but it is more difficult to do “quick and dirty” ad-hoc analyses in SciMAT. Its main drawback is the current lack of a user interface to export data matrices that could be used in statistical software. Users can export the data for further analyses only through (undocumented) scripts or limit the analyses to those done in SciMAT.

At least two other software options are worth mentioning. Loet Leydesdorff’s website stores a number of simple software programs that implement various bibliometric methods (Leydesdorff, 1999). These are very basic programs run from the command line that transform WOS data into matrices that can be used in statistical and network analysis software. Its use is very simple, but its preprocessing capabilities are very limited. CiteSpace II (Chen, 2006) is another option with comprehensive bibliometric capabilities. It has many features far beyond what is needed for basic science mapping, but the learning curve is pretty steep. For a comprehensive analysis of available bibliometric software and their features, see Cobo, Lopez-Herrera, Herrera-Viedma, & Herrera (2011).

Identifying subfields

Identifying subfields with quantitative analysis is one of the biggest strengths of bibliometric methods. Various dimensionality reduction techniques are applied. The most common are exploratory factor analysis, cluster analysis, multidimensional scaling (MDS), and network analysis community finding algorithms (Cobo et al., 2012). Researchers are advised to use several grouping methods simultaneously to check the robustness of the results.

Exploratory factor analysis, cluster analysis, and multidimensional scaling require a similarity matrix (produced with bibliometric software) as an input for statistical software (e.g. SPSS, Stata, R). Bibliometric software produces a co-occurrence frequency matrix in which the elements of the matrix are co-citations (for co-citation analysis), shared reference counts (for bibliographical coupling), number of coauthored papers (for co-author analysis) or word co-occurrences (for co-word analysis). However, normalized similarity measures

are often preferred to raw co-occurrence counts, e.g. Pearson's r , Salton's cosine, Jaccard index. These measures normalize the matrix and compensate for different occurrence levels among items. Normalization is especially recommended for cluster analysis as it is sensitive to scaling issues, but exploratory factor analysis and MDS benefit from normalization as well. Network analysis algorithms also use network topology to find network subgroups and can work with raw co-occurrence counts so normalization of a similarity measure is not necessary (Wallace, Gingras, & Duhon, 2009).

The similarity measure most often used is Pearson's r correlation. However, its use has been the subject of considerable controversy in bibliometric methodological literature. Ahlgren, Jarneving, & Rousseau (2003) claimed that Pearson's r does not satisfy mathematical requirements for a good similarity measure and suggested that other measures should be preferred. However, White (2003) showed that for practical purposes Pearson's r is a valid and robust measure of similarity for the purpose of mapping research specialties that consistently produces interpretable maps.

Exploratory factor analysis (EFA) with principal component analysis (PCA) as an extraction method is one of the most frequently used techniques for finding subgroups in bibliometric studies. Since no theoretical relationships between factors are expected in advance, PCA as an extraction method is appropriate (Conway & Huffcutt, 2003), but requires the researcher to specify the number of factors in advance. Several methods exist for choosing the number of factors: scree test, Kaiser's criterion and others. We suggest using these methods just as a starting point. Choosing the number of factors is a substantive as well as a statistical issue (Fabrigar, Wegener, MacCallum, & Strahan, 1999). Several solutions with various factors should be examined to determine their interpretability/practicality before the number of factors is determined. If too few factors are used, the latent structure is not revealed while, if too many factors are used, it becomes difficult to interpret the findings. Accordingly, several trials should be performed to arrive at the best representation of the data.

One advantage of EFA is that because items (documents, authors, journals, words) can load on to more than one factor, it can demonstrate the breadth of contributions that span multiple factors. Important work is also often universal so it would be assigned to multiple subgroups of publications (Börner et al., 2003). Items with loadings greater than 0.7 should be regarded as core contributions to that factor and loadings larger than 0.4 should be reported as factor members (McCain, 1990). There are two types of rotation methods in FA: orthogonal and oblique. Orthogonal rotation assumes that factors are not correlated and works best when factors are independent (D. Zhao & Strotmann, 2008). Oblique rotation is useful when factors are correlated and can produce a component correlation matrix to indicate the degree of correlation between factors. Because bibliographic data represents subgroups of a research specialty, we can reasonably expect factors to be correlated (McCain, 1990) but, if

factors are uncorrelated, orthogonal and oblique rotations will give similar results (Conway & Huffcutt, 2003). Therefore, oblique rotation is the preferred method when dealing with bibliographic data.

Hierarchical cluster analysis (HCA) is another frequently used technique for finding subgroups. This method produces a dendrogram based on the similarity of analyzed items, the choice of where to cut the dendrogram to produce clusters is left to the researcher. HCA has no generally accepted stopping rules to guide the researcher to the best set of clusters (McCain, 1990). There is a variety of HCA procedures: single linkage, complete linkage, average linkage, Ward's method. Of these, Ward's method is the most frequently used for bibliometric analysis. McCain (1990) found that both complete linkage and Ward's method produce similar and interpretable results. Because all analyzed items are contained in the solution, filtering of unwanted items beforehand is necessary. Using absolute citation counts in a matrix is less appropriate for clustering algorithms as they produce a network in which the most cited publications dominate (Gmür, 2003).

Multidimensional scaling (MDS) can analyze any kind of similarity matrix. It produces a map of objects in a low- (usually two-) dimensional space by optimizing distances between objects to reflect a similarity measure. Items regarded as more similar are presented as closer on the map. The items, however, are not explicitly assigned to groups; this decision is left to the researcher. MDS is limited to small data sets as big maps become increasingly difficult to read and interpret. It does not produce explicit links between objects and its major drawback is that there are no firm rules to interpret the nature of the resulting dimensions (Börner et al., 2003). Compared with other methods for identifying subfields in this section, MDS has serious limitations and few relative advantages.

Network community finding algorithms have made several important advances in recent years due to the explosion of interest in the Internet, which can be analyzed with social network analysis methods. However, these advances are still not being exploited in bibliometric studies to a full extent so network analysis algorithms continue to hold huge potential for the future. In this section, we will describe two effective community finding algorithms: the Louvain method (Blondel, Guillaume, Lambiotte, & Lefebvre, 2008) and the Islands algorithm (Zaveršnik & Batagelj, 2004). Several other network community finding methods exist which have not yet been used in bibliometric studies. For a detailed and comprehensive treatment of the various network community finding methods, see Fortunato (2010).

The Louvain method (Blondel et al., 2008) has been found to be very fast for large networks and to provide excellent accuracy (Liu, Glänzel, & Moor, 2012). This method uses the notion of network modularity, which measures the meaningfulness of network division into communities. The Louvain algorithm starts with assigning each node to separate community.

It then iterates through all communities, checking whether adding a node from one community to another causes an increase in modularity and choosing the change with greatest increase in modularity. It repeats the process until there is no change in community structure. The method works very well on co-citation networks and can be used on extremely large networks. The limitation of the Louvain method is that it assigns all network nodes to groups so item filtering to include only important items is necessary beforehand. Sometimes there are items in the network that substantially do not belong to any group, but are assigned one anyhow or the method produces artifacts - groups with just one node.

The Islands algorithm (Zaveršnik & Batagelj, 2004) can be illustrated with a mountain range submerged in water (in our case, the height of the mountains represents similarity strength between units of analysis – documents, authors, journals or words). When the water is drained, the highest peak appears as an island first, and then the lower peaks gradually emerge. These islands represent clusters of highly similar items. An important advantage of this algorithm is that it can uncover groups of publications with varying degrees of link intensity. In case of co-citation links, it enables less cited groups of items to be uncovered. In summary, a group of items represents a peak within a mountain range when within-group similarity links are stronger than those with out-of-group publications. The main advantage of the Islands algorithm is that the found groups (islands) are only a subset of the whole network and so it is not necessary to limit the number of items beforehand. The groups that are found are very dense and cohesive, but are usually smaller than those found with other methods because only the strongest members are included.

Exploratory factor analysis, cluster analysis, and MDS provide complementary, often reinforcing results when used on the same or related similarity matrices (McCain, 1990). Several researchers found very consistent results when applying cluster analysis and exploratory factor analysis to the same bibliometric data (e.g. Di Stefano, Gambardella, & Verona, 2012; Samiee & Chabowski, 2012). The advantage of exploratory factor analysis over cluster analysis is that it does not force objects into groups (clusters), but is able to accommodate the universality of work, which can belong to multiple factors. This property of exploratory factor analysis can make a clear delimitation of subgroups difficult, but it can identify publications that serve as boundary spanners between different subtopics of research. However, Gmür (2003) found that factor analysis in the conditions of high structural complexity does not generate a true representation of co-citation clusters. Network analysis methods are a fresh approach to finding subgroups which has yet to take hold in bibliometric studies. We believe network analysis methods have several advantages that make them worthwhile using: they are effective and accurate, do not require normalization of similarity matrices (so researchers can avoid the controversy over which similarity measure to choose), and the analysis can be done within the same software tool that is used for visualization.

1.3.4 Step 4: Visualization

The map of a field is primarily a visualization of its network structure. Traditionally, multidimensional scaling (MDS) was the approach most often used for visualizing bibliometric data (White & McCain, 1998). MDS is a technique for creating maps from proximity matrices so that an underlying structure can be studied (McCain, 1990). However, MDS is gradually being supplanted by network analysis visualization methods.

Network analysis produces visualizations of scientific fields in which network nodes represent units of analysis (e.g. documents, authors, journals, words) and network ties represent similarity connections. More strongly connected nodes are drawn closer together. Depending on the unit of analysis, several different types of maps of a scientific field can be constructed. The most common are maps based on documents. Author-based maps are also widespread (Börner et al., 2003) and come in two forms: author co-citation maps are constructed to represent the intellectual structure of a field, while co-authorship maps are used to reveal the structure of scientific networks based on collaborations. Finally, semantic maps (i.e. co-word analyses) can be used to represent the cognitive structure of a field.

Showing different units of analysis is possible on the same map with 2-mode networks, but this has been used very rarely. An exception is Vogel (2012) where an innovative map of an entire management discipline featured connections among research field subgroups (document groups collapsed into clusters) and scientific journals. Zhao & Strotmann (2008) presented an alternative visualization of a research field in a 2-mode network, where subgroups found by PCA are represented as type-1 nodes connected to the authors (type-2 nodes). Authors could be connected to several subgroups.

The choice of layout algorithm determines the aesthetics and usefulness of network drawing. The most common layout algorithms are Kamada-Kawai and Fruchterman-Reingold. Both are members of the spring-embedder family of algorithms (Kobourov, 2012). These are typically useful for small networks (Boyack & Klavans, 2014) because the graph layouts generally have many local minima which makes it difficult for algorithms to produce good layouts of large graphs. Fruchterman-Reingold aims to keep adjacent nodes close together, while Kamada-Kawai takes a graph-theoretic approach. It tries to minimize the difference between geometric distances between two nodes in a network drawing and the graph-theoretic pairwise distances. The latter are determined by the shortest path between the nodes. One recommended option is to first use the Kamada-Kawai algorithm for an approximate layout and to subsequently employ the Fruchterman-Reingold algorithm to improve the drawing (Collberg, Kobourov, Nagra, Pitts, & Wampler, 2003).

Network analysis software can calculate centrality measures (e.g. degree, betweenness, closeness). These measures have different meanings depending on the network analyzed. In

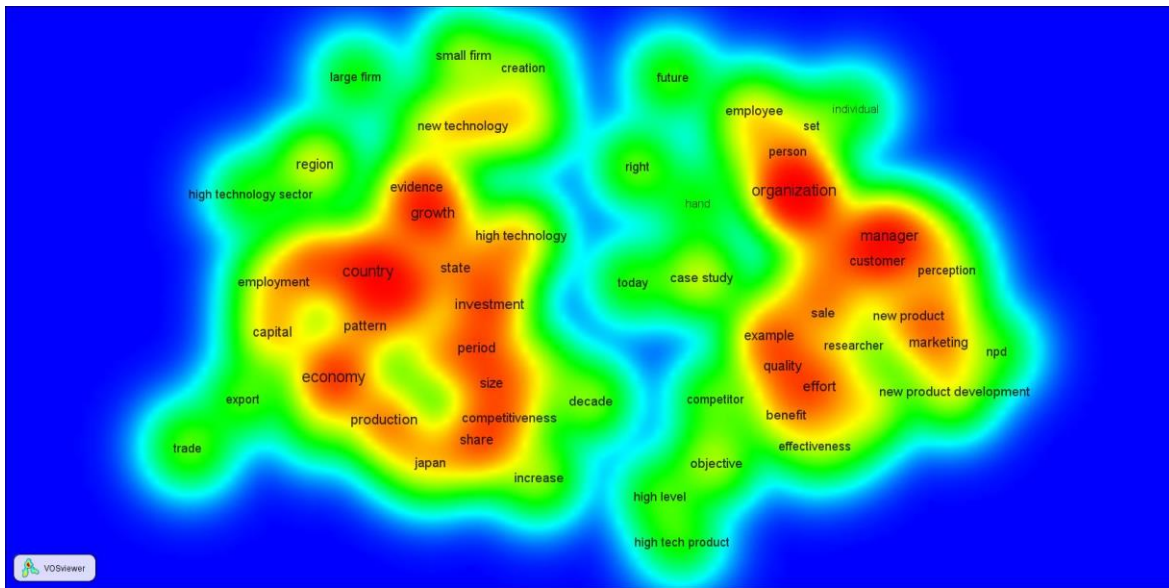
a co-authorship network, an author's degree centrality represents how many other authors have written a paper with him (Fischbach et al., 2011). High betweenness centrality is an indicator that an author is a bridge between different research streams. Authors scoring high on closeness centrality can reach other authors in the network through a shorter chain.

With the advancement of network analysis tools we see no compelling reason to continue using MDS for visualization purposes. Network analysis software can produce MDS-like visualizations, but has many more options and features to choose from. The software packages most often used for network visualization are UCINET (Borgatti, Everett, & Freeman, 2002) and Pajek (Batagelj & Mrvar, 1998). Both of these software tools have a long history and a large number of features. Their main drawback is the limited number of community finding algorithms that are implemented in these packages. In addition, their speed of development is slower compared to open-source tools like Gephi and the R iGraph package.

Gephi is open-source network analysis and visualization software that is fast gaining traction in the social network analysis community. Its rapid development is due to its open-source nature and because it is more easily extendable than other options. Another visualization option is the statistical software R with its powerful iGraph package (also available in Python). A big advantage of iGraph package is that it has already implemented a large number of community finding algorithms. R is also a very flexible environment that can handle very different analysis tasks including PCA, MDS and/or cluster analysis. Producing basic bibliometric calculations in specific bibliometric software and handling all other analysis in R is a very powerful and flexible option.

One challenge researchers face is how to visualize the changes in the research field through several time periods. A good option to represent these changes is a bar graph, where each row represents a publication in the intellectual structure and the width of a bar left or right from the zero axis represents whether this publication was more or less influential than in the previous period. A good example of the use of this graph can be found in Shafique (2013; p. 74). When implementing co-word analysis, an additional option for visualization of the conceptual structure of a field are graphs called heat maps. These maps use warmer colors and bolded fonts to emphasize concepts that are frequently used, while words which are used only sporadically are shown in colder colors and subdued smaller fonts. An example of a heat map is shown in Figure 3, which visualizes the words in abstracts of research papers dealing with the high-tech firms published in management journals between 1973 and 1998. Two large groups of words can be distinguished: the first deals with the role of high-tech firms in economic growth, the second shows the words related to the management of high-tech firms.

Figure 3. Co-word analysis of abstracts of research papers on the topic of management in high-tech firms published in 1973 to 1998.



1.3.5 Step 5: Interpretation

The final step in bibliometric analysis is to interpret the findings. Bibliometrics is no substitute for extensive reading in the field. Documents that appear in the analysis need to be thoroughly examined to reach valid conclusions. Researchers with in-depth knowledge of the field have a distinctive advantage here. However, they need to be careful not to try to fit the analysis to their existing preconceptions, but the opposite: to use their knowledge to enhance the findings. Bibliometric methods will often reveal the structure of a field differently from the classification of traditional literature reviews so these differences need to be reconciled. Science maps provide a starting point for analytical examination, but are not an end in itself. Interpretation strategies in bibliometric analysis are dependent on the focus of the paper authors are writing. We argue there are three major types of focus bibliometric papers can have: focus on structure, focus on dynamics and focus on a narrow research question.

First type of paper focuses on structure. The aim is to analyze the relations among structural elements (groups of publications, authors, concepts), find how they relate and influence each other and examine their role in substantive questions the research field asks. Focus on dynamics is the second type of paper that can employ bibliometric methods. The goal of this type of paper is to track the development of a research field through time. Researchers should divide the bibliographic data into several multi-year periods and take snapshots of the structure of the field for each interval. Interpretation strategy would then try to explain how the structure changed and why did this happen. It would determine which elements are new in certain period and which are in decline. A good example of this type of focus is Vogel

(2012), who tracked the development of the management discipline over several decades. His study used co-citation and network analysis to identify the theoretical perspectives that were dominant in each decade.

Alternative type of paper is a focused paper with very specific research question. Typically, these papers will have small empirical bibliometric part that is used to illustrate or prove authors claims and extensive discussion of the relation of these claims with existing literature. An example of a focused question would be “Is research stream X over-reliant on theoretical perspective Y?” Researchers could then use citation analysis to prove that the research in field X is indeed highly influenced by the theoretical perspective Y and that references to other potentially useful theoretical perspectives are few or nonexistent. Other research goals could fall under this focus type. For instance, Volberda, Foss, & Lyles (2010) used bibliometric methods to investigate contextual factors that affect absorptive capacity and develop an integrative model that identifies the multilevel antecedents, process dimensions, and outcomes of absorptive capacity.

1.4 The intellectual structure of Organizational Research Methods

To demonstrate the use of bibliometric methods we performed a bibliometric analysis of the Organizational Research Methods journal. All steps necessary to reproduce this analysis are detailed in Appendix B. Readers can also repeat the analysis on their own data by following the steps with data of their chosen research field.

We set out to examine the intellectual structure of the Organizational Research Methods (ORM) journal. Our expectation was that this investigation would reveal which research methods are dominant within organizational research. We decided to use citation and co-citation analysis. With citation analysis we aimed to find the most influential documents (books or articles) that were referenced in ORM. Co-citation data provided the structure of the knowledge base of ORM.

We searched the Web of Science database for “Organizational Research Methods” in the publication name. The search returned 483 articles, but the analysis based on publication years revealed that the data for 1999 and 2000 were missing so we decided to only use published articles from 2001 to 2014, covering almost 15 years. Limiting the search to that time period left us with 465 entries that formed the data sample for our analysis. We exported the bibliographic data with cited references for these 465 articles and imported it into BibExcel software for bibliometric analysis. We calculated the list of the most cited documents and the most cited journals in BibExcel. Having the list of the most cited journals we proceeded to clean the citation data as journal names often appear in different forms in bibliographic databases.

Next step in the process was choosing the cut-off point to limit the number of documents for co-citation analysis. Co-citation is not performed on the core documents (i.e. the 465 articles published in ORM) but on the documents cited by these. Limiting the scope of documents for co-citation analysis is a judgment call which tries to balance two competing objectives: providing as broad a representation of the intellectual structure as possible vs. providing a more focused, clean representation. If we limit the articles too much (i.e. choose a citation cut-off point too high), we risk missing some smaller groups of publications that are perhaps less cited, but nevertheless important. If we set the cut-off point too low, we get another set of problems. Bigger groups of documents are harder to visualize. Less cited documents carry less information for co-citation analysis, which increases the probability for spurious co-citation connections. After several trials with different cut-off points, we decided to limit our analysis to 112 documents cited 9 or more times by the articles published in the ORM.

We calculated the co-citation data and exported it to the Pajek network analysis software for further analysis and visualization. Applying the Louvain community finding algorithm in Pajek, we found 11 subgroups of cited publications that represent the intellectual structure of the ORM journal. We report the results of our analysis in the following sections.

1.4.1 Citation analysis

The most cited documents by articles published in ORM are presented in Table 5. A glance at the list reveals the knowledge base of ORM and provides hints about the topical structure of ORM, which we will further investigate with co-citation analysis. The most cited document is *Statistical Power Analysis for the Behavioral Sciences* (Cohen, 1988), with 31 citations. The top of the list is dominated by books on psychometric theory, linear regression and multilevel analysis. We can see that some books appear in several editions, e.g. both 1978 and 1994 editions of Nunnally's *Psychometric Theory* are featured on the list. Other works include seminal works on grounded theory, meta-analysis and structural equation modeling. The documents in this table show how reference lists in the SSCI (WOS) database are represented.

Table 5. Most cited documents in Organizational Research Methods.

Citations	Document
31	Cohen J, 1988, Stat Power Anal Beha
27	Nunnally J, 1994, Psychometric Theory
27	Cohen J, 2003, Appl Multiple Regres
26	Bollen K. A, 1989, Structural Equations
24	Raudenbush S, 2002, Hierarchical Linear
23	Campbell D, 1959, V56, P81, Psychol Bull
22	Cohen J, 1983, Appl Multiple Regres
21	Vandenberg Robert J, 2000, V3, P4, Organ Res Methods
21	Chan D, 1998, V83, P234, J Appl Psychol
21	James L, 1984, V69, P85, J Appl Psychol
20	Nunnally J. C, 1978, Psychometric Theory
20	Baron R, 1986, V51, P1173, J Pers Soc Psychol
20	Cook T. D, 1979, Quasiexperimentation
20	Scandura T, 2000, V43, P1248, Acad Manage J
19	Bliese P. D, 2000, P349, Multilevel Theory Re
19	Gephart R, 2004, V47, P454, Acad Manage J
19	Aiken L. S, 1991, Multiple Regression
18	Kozlowski S, 2000, P3, Multilevel Theory Re
18	Glaser B. G, 1967, Discovery Grounded T
18	Chan D, 1998, V1, P421, Organ Res Methods
18	Hu L, 1999, V6, P1, Struct Equ Modeling
18	Hunter J. E, 2004, Methods Metaanalysis
16	Bryk A. S, 1992, Hierarchical Linear
15	Aguinis H, 2005, V90, P94, J Appl Psychol
14	Podsakoff P, 2003, V88, P879, J Appl Psychol
14	Eisenhardt K, 1989, V14, P532, Acad Manage Rev
14	Lance C, 2006, V9, P202, Organ Res Methods

The most cited journals in ORM are shown in Table 6. We see that the most cited journal is the Journal of Applied Psychology with 1,637 citations, almost twice as many as the second on the list, which is ORM. Perhaps surprisingly for a methods journal, most of the top of the list is taken up by top-tier management journals (Academy of Management Journal, Strategic Management Journal, Journal of Management), which is an indicator of the disciplinary breadth of ORM. Most numerous on the list, however, are psychology journals, meaning that methods for micro management (psychology, OB and HR) research are forming a large share of topics in ORM.

Table 6. Most cited journals in Organizational Research Methods.

Citations	Journal
1637	Journal of Applied Psychology
888	Organizational Research Methods
823	Academy of Management Journal
557	Strategic Management Journal
509	Journal of Management
490	Psychological Bulletin
478	Personell Psychology
439	Academy of Management Review
354	Administrative Science Quarterly
337	Psychological Methods
223	Journal of Personality and Social Psychology
184	Educational and Psychological Measurement
184	American Psychologist
183	Journal of Organizational Behavior
182	Applied Psychological Measurement
175	Psychometrika
173	Organization Science
170	Multivariate Behavioral Research
156	Structural Equation Modeling
136	Organizational Behavior and Human Decision Proc
123	Journal of International Business Studies
113	Psychological Review
109	Journal of Management Studies

1.4.2 Co-citation analysis

After experimenting with several parameters for the Louvain algorithm that determine the granularity of groups, we settled on an 11-group solution. The algorithm originally found 15 groups, but 4 groups contained only one element of non-methods origin – seminal works of Porter, Weick and DiMaggio – so we decided to treat these four groups as outliers and report only the first 11.

The first three groups of intellectual structure represent the knowledge base of multilevel research methods. We labeled these groups Multilevel theory, Interrater reliability and agreement (IRR & IRA) and Multilevel analysis (Figures 4-6). The cohesion and breadth of these groups indicate that debates about multilevel methods are one of the most important themes in ORM.

Figure 4. Multilevel theory

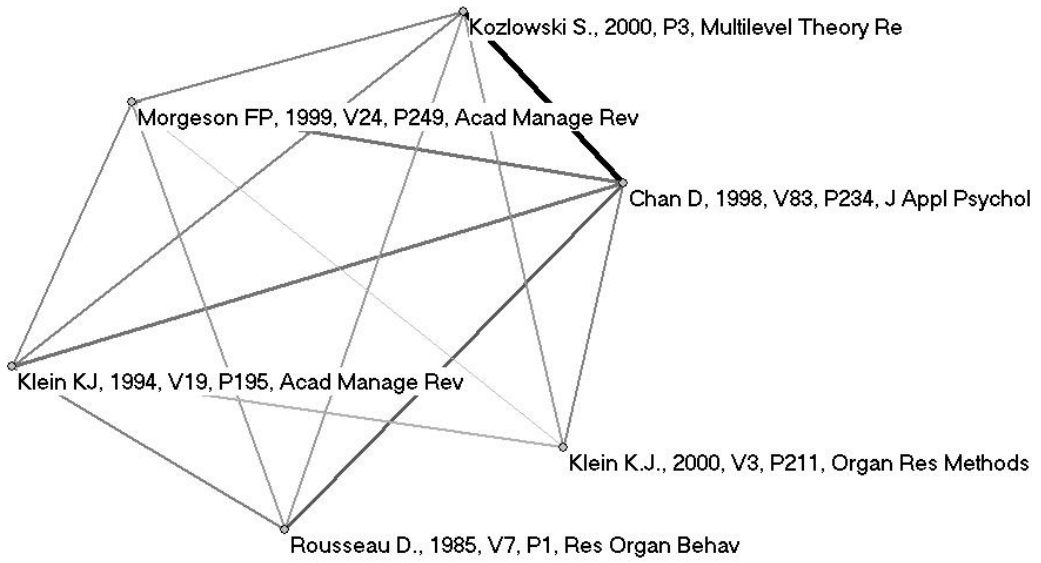


Figure 5. Interrater reliability and agreement (IRR & IRA)

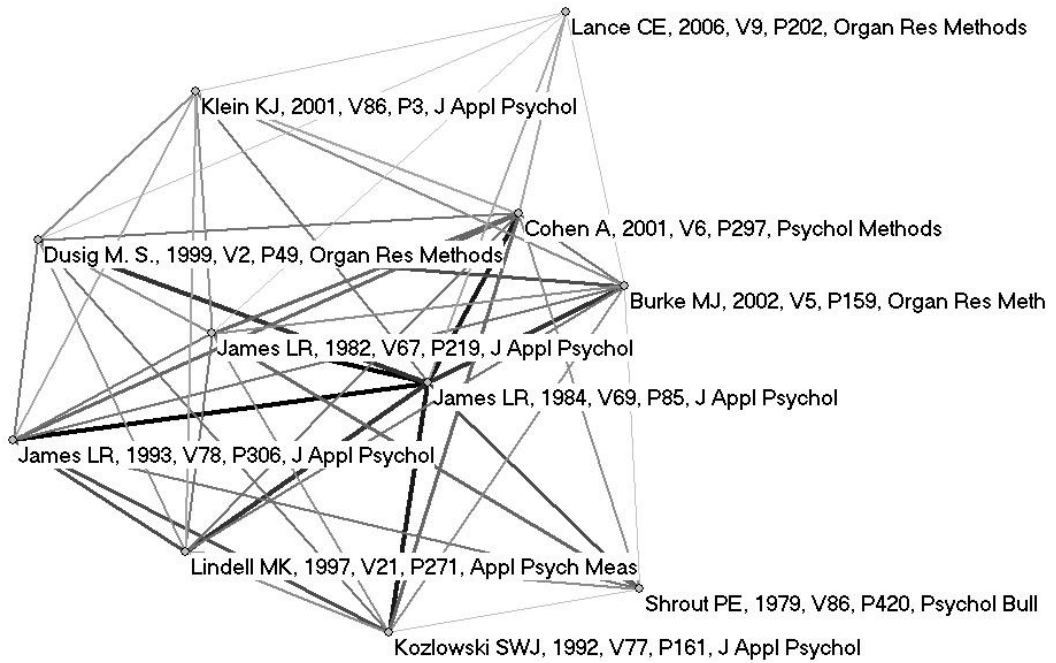
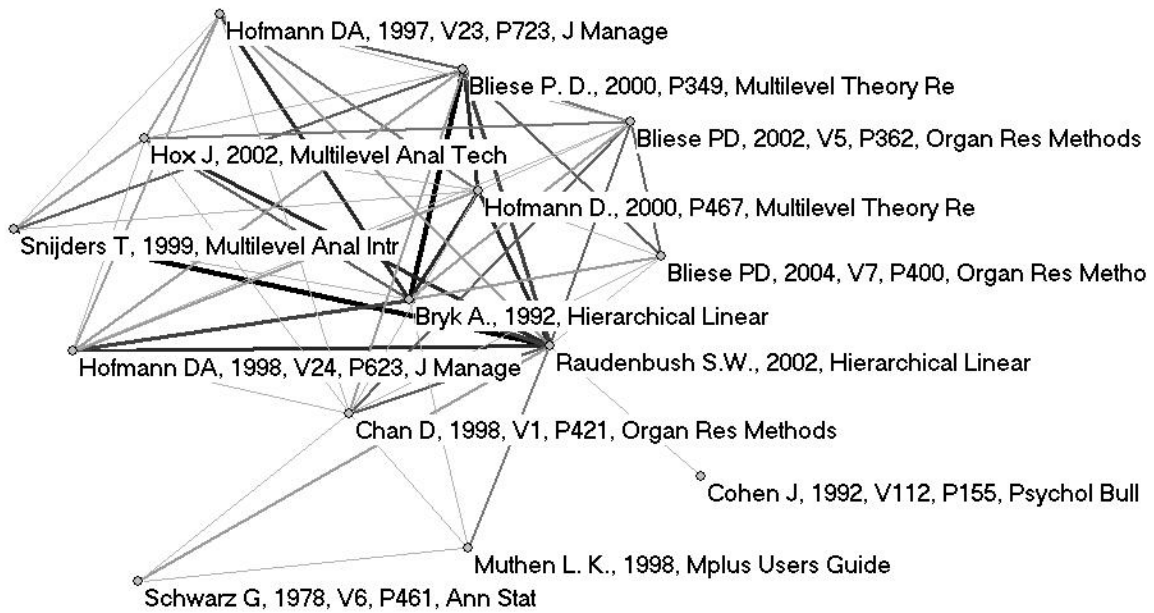


Figure 6. Multilevel analysis



The fourth group contains articles and books on psychometric measurement theory and structural equation modeling (Figure 7). The group on relative predictor importance (Figure 8) is one of the smaller and deals with estimating the importance of predictors in multiple regression. This group is separated from one of the largest groups that deals with multiple regression (shown in Figure 9).

Figure 7. Psychometric theory and structural equation modeling

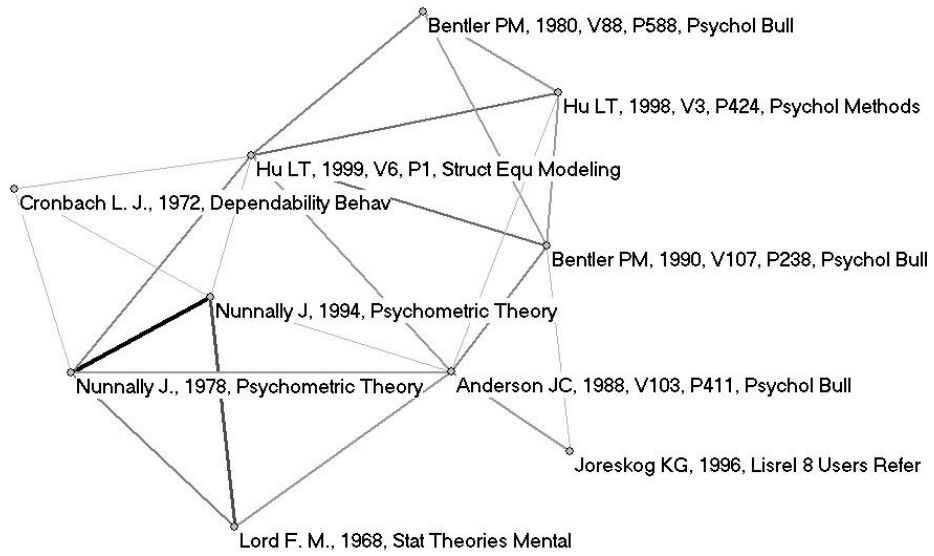


Figure 8. Relative predictor importance

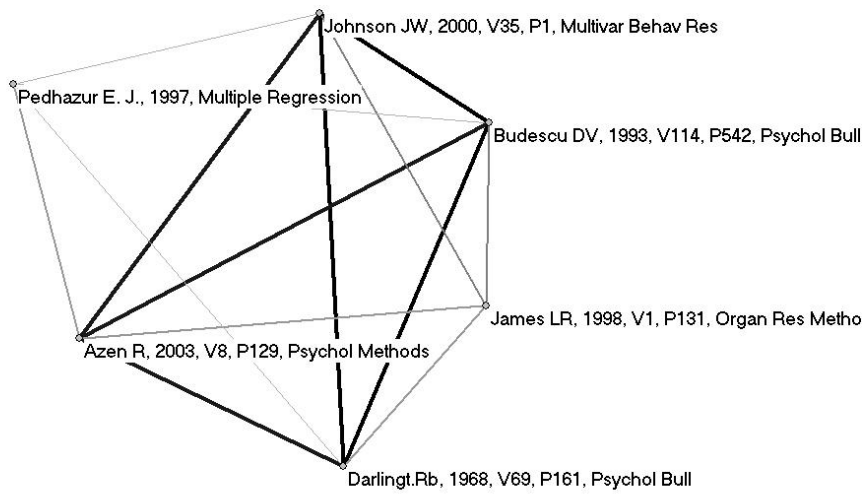
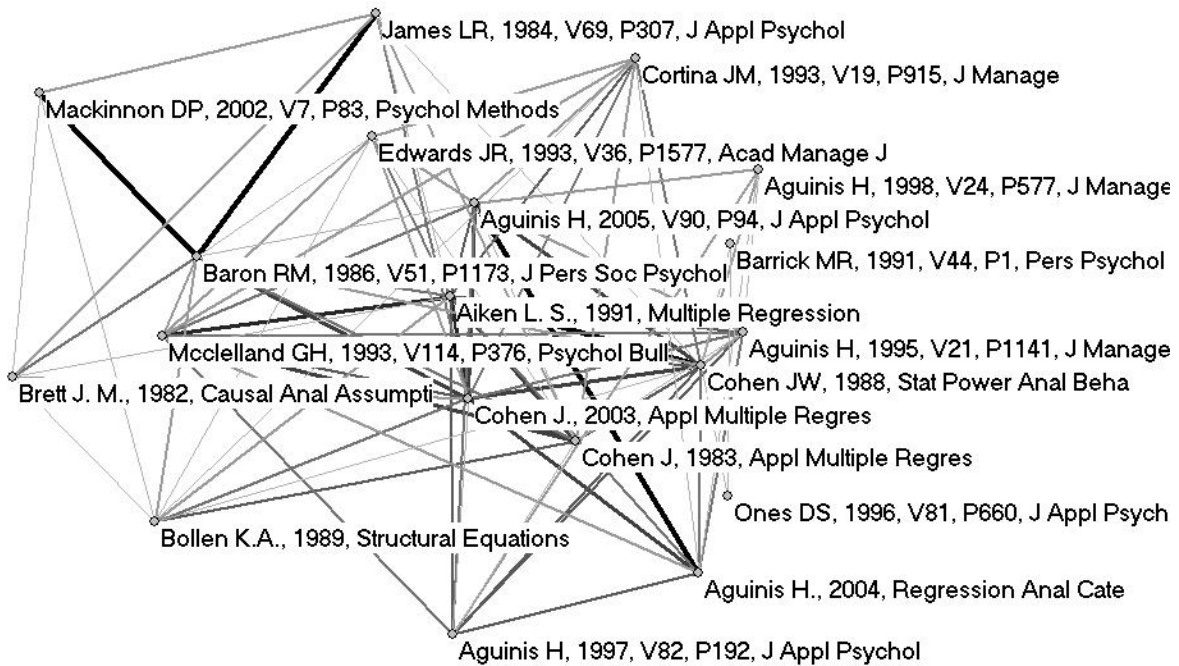


Figure 9. Multiple regression



We labeled the subsequent groups Measurement invariance, Validity & method variance and Qualitative research. The tenth group is peculiar because it shows two different topics: half of the groups contain debates about the relevance of management theory, while the other half is dedicated to meta-analysis. The eleventh group is the smallest with three items on the topic of missing data.

Figure 10. Measurement invariance

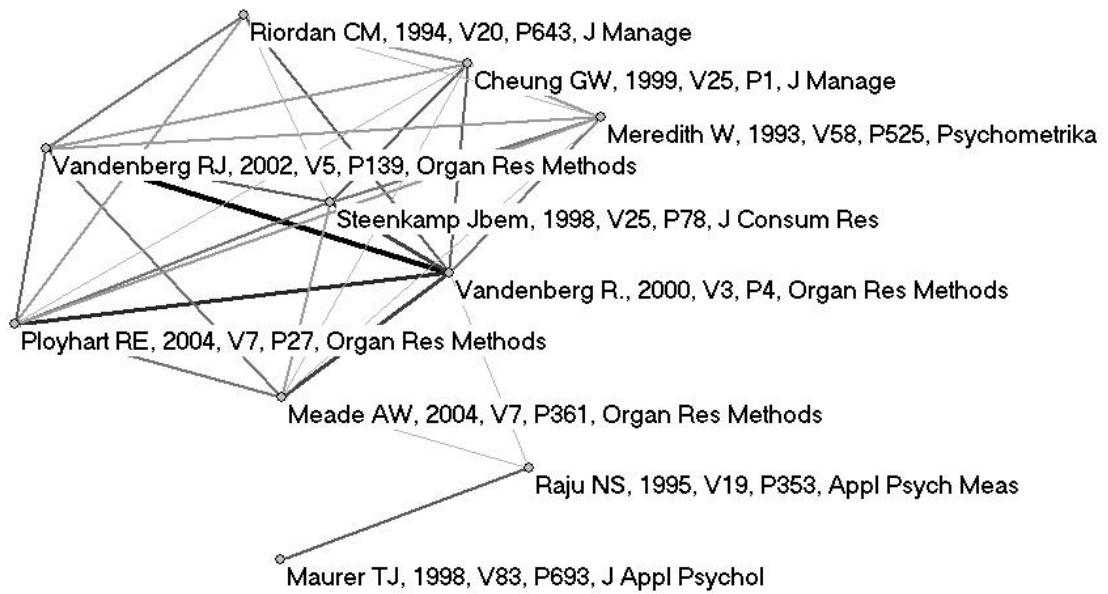


Figure 11. Validity and method variance

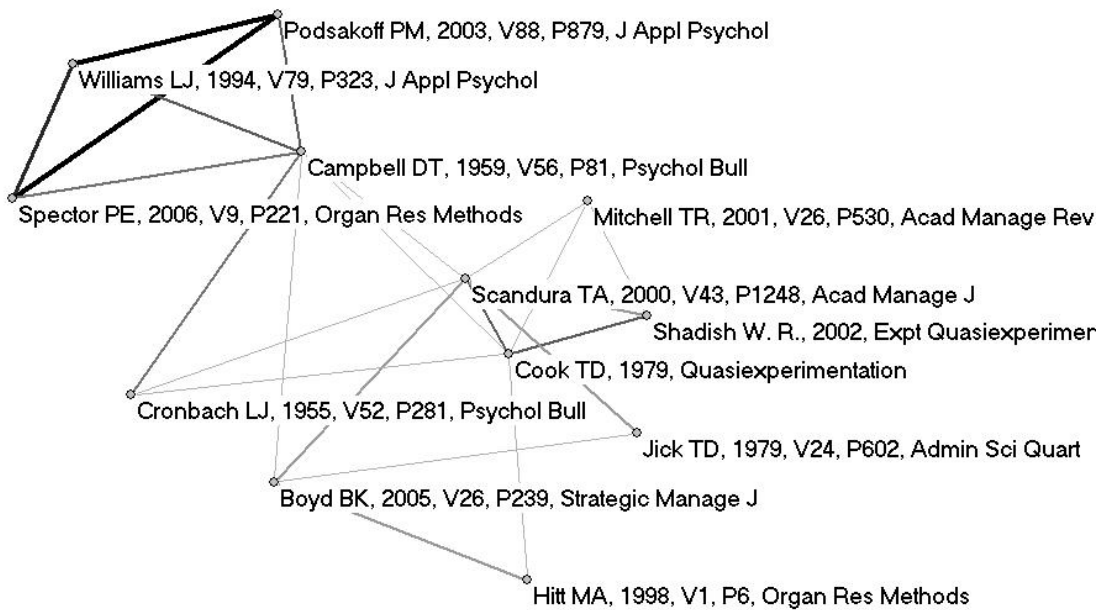


Figure 12. Qualitative methods

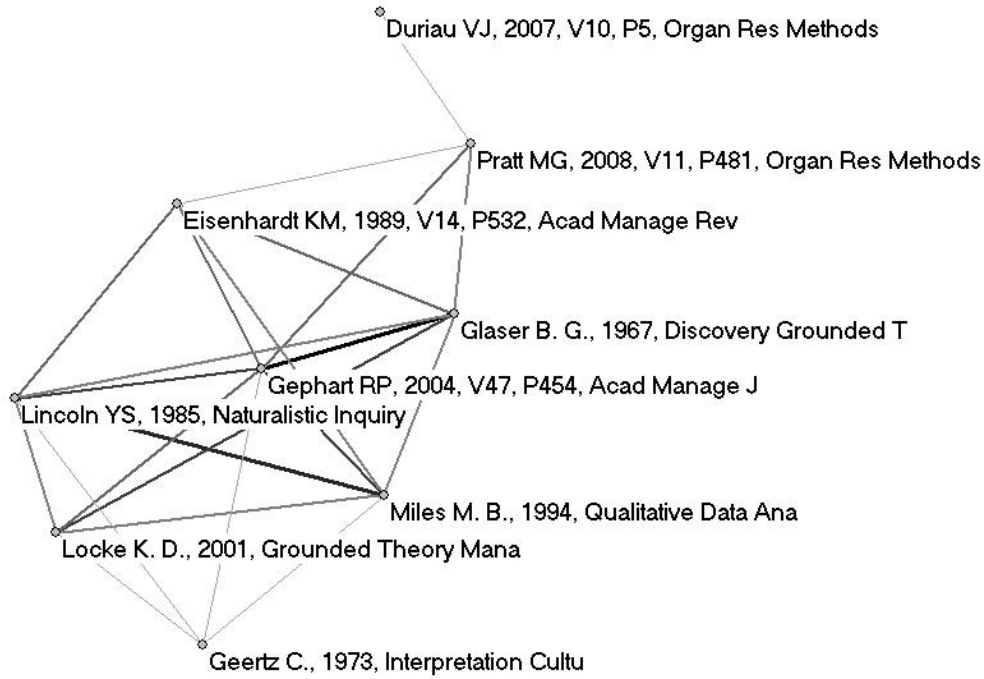


Figure 13. Meta-analysis and management theory

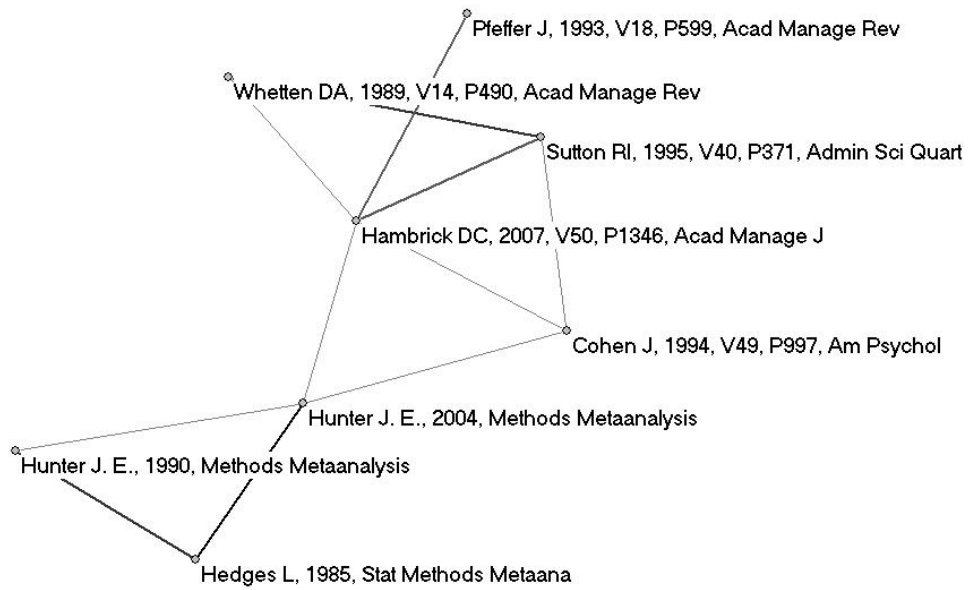
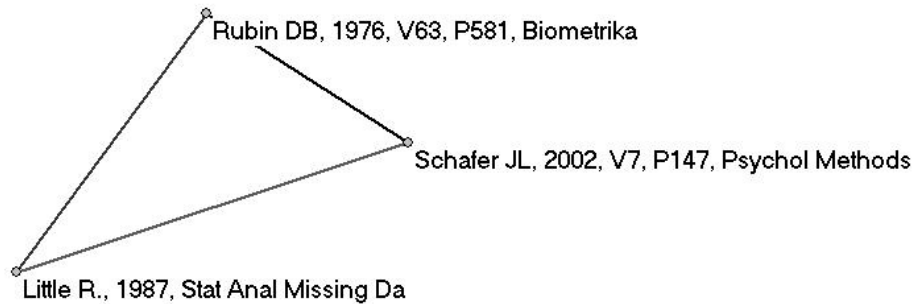


Figure 14. Missing data



What might be concluded from this brief analysis? High citations to psychology journals suggest methods issues in micro research are dominant in the conversations in the ORM, although the evidence from citation rates of Strategic Management Journal and some co-citation groups reveal that ORM also caters to debates in macro fields (e.g. strategy).

Out of eleven groups, only one is about qualitative research, meaning that quantitative methods are still the most used methods in organizational research. Quantitative conversations are mostly centered on either measurement or analysis problems, while theory issues are the focus of two found groups. Most of our results are consistent with the content analysis of the first decade of ORM journal (Aguinis, Pierce, Bosco, & Muslin, 2009). However, our findings suggest that the importance of multilevel research methods has gained in prominence in the seven years since the end of the period analyzed by Aguinis and colleagues. Additionally, our analysis can be used as an aid for assigning readings in methods doctoral courses. We identified the most impactful methods publications that are used by the members of ORM community who expressed their opinions by citing these documents.

1.5 Conclusion

Bibliometric methods reveal great potential for the quantitative confirmation of subjectively derived categories in published reviews as well as for exploring the research landscape and identifying the categories. We proposed guidelines for conducting the science mapping of management and organization research streams.

Several new bibliometric methods are likely to become prominent in the future. Hybrid methods combining the existing bibliometric and semantic approaches (e.g. bibliographic coupling with latent semantic indexing) could be used to detect new emerging topics in scientific research (Glänzel & Thijs, 2012) and are rapidly becoming the preferred basis of the mapping and visualization of science (Thijs, Schiebel, & Glänzel, 2013). Connecting documents through a combination of bibliometric and second-order textual similarities can improve the accuracy of document clustering. Second-order similarities take the lexical content into account and can overcome problems of simple co-word methods like synonyms and spelling variances (e.g. British vs. American spelling of words).

Topic modeling (Blei, 2012) is a family of content analysis methods that originates from machine learning. Latent Dirichlet allocation (LDA) is the most widely used topic modeling method that is able to decipher the topical structure of a large corpus of unstructured documents. It assigns the probability of topics to documents and determines which words are connected to particular topics. Topic modeling could be applied to document abstracts and full texts, which can be later connected based on their thematic similarity. These methods hold great potential for expanding the scope of mapping the management and organization domain. Management scholars can capitalize on these advances in two ways: they may wait for suitable software to be developed or collaborate with information scientists on the forefront of advancing bibliometric research.

We think that science mapping with bibliometric methods is useful in two main ways: (1) to help researchers new to a field quickly grasp the field's structure; and (2) to introduce quantitative rigor into traditional literature reviews. We envision that in the future bibliometric methods will become the third major approach (in addition to traditional qualitative literature reviews and meta-analyses) used for reviewing scientific literature. However, new doctoral students need to be trained in the technique. Some doctoral programs already provide this, but further proliferation of this practice is called for. This chapter represents our effort to promote these methods and provide a thorough introduction to bibliometric methods for researchers unfamiliar with them.

We are aware that other bibliometric studies have been published in journals not listed by the SSCI or are simply unpublished. However, we included the highest quality journals so our synthesis represents the state of the art of bibliometric research in management and organization. One trend is obvious. The bar for publishing bibliometric studies is being raised higher. Bibliometric methods are transforming from being novel methods interesting in their own right to a tool used for a specific purpose; namely, to increase the rigor and structuring of literature reviews. Researchers applying bibliometric methods need to choose their research questions much more carefully and perform the research rigorously.

Finally, bibliometric methods are no substitute for extensive reading and synthesis. Bibliometrics can reliably connect publications, authors or journals, identify research substreams, and produce maps of published research, but it is up to the researcher and their knowledge of the field to interpret the findings – which is the hard part.

2 THEORETICAL FOUNDATIONS OF FIRM GROWTH

We use the bibliometric methods of citation and co-citation analysis to identify the theoretical foundations of firm growth. We show that resource-based explanations of growth dominate contemporary research. We identify ten distinctive groups of theoretical foundations. The dominant two are: (1) strategic entrepreneurship, closely associated with the resource-based and related perspectives; and (2) economics, which is largely empirical and atheoretical. The remaining eight groups manifest the diversity and fragmentation of firm growth research. Drawing on our findings, we outline a research program to take the field forward and suggest that the two major research streams would benefit from greater integration.

2.1 Introduction

Ever since Edith Penrose (1959) theorized that a firm's resources directly influence its growth, the firm growth phenomenon has been one of the most examined topics in strategy and entrepreneurship research. By analyzing the drivers of firm growth researchers have tried to determine why some firms grow faster than others, while also investigating how firm growth contributes to ultimate organizational success. In addition, the phenomenon of firm growth has attracted the attention of policymakers ever since Birch's groundbreaking (1979) research on the topic. He asserted that a handful of fast-growing smaller firms was overwhelmingly responsible for job creation and the economic recovery of the U.S. economy. Now, the idea that these smaller growing firms, often referred to as gazelles (Henrekson & Johansson, 2010), should be the target of policymaking efforts, has become generally accepted knowledge in policymaking discourse (Mason & Brown, 2011; Shane, 2009). Recent policy reports emphasized a significant focus on high-growth firms (Mitusch & Schimke, 2011; OECD, 2013). Finally, the idea of firm growth is certainly appealing to entrepreneurs and their investors as an early sign of the future profitability returns a growing firm may incur and it is often used as an ultimate measure of success.

In spite of sustained interest and effort, recent reviews have painted a grim picture about the actual findings of growth research. Statistical models used in research are able to explain only a modest amount of growth rate variance (Coad, 2009). Many reasons have been put forward to explain this lack of tangible results. It has been argued that firm growth research began asking the "how much" questions too soon, certainly before really answering the "how" questions (McKelvie & Wiklund, 2010). Too many researchers use cross-sectional designs in an attempt to explain a longitudinal process (Davidsson, Delmar, & Wiklund, 2006). Different growth indicators have low concurrent validity and seem to pick out different dimensions of growth processes (Shepherd & Wiklund, 2009). The heterogeneous environmental conditions in different contexts and industries prevent the building of a

unified general theory of growth (Leitch, Hill, & Neergaard, 2010). Finally, the lack of theorizing could be blamed (Achtenhagen, Naldi, & Melin, 2010). We simply lack systematic evidence on which theories are actually used in contemporary growth research and whether these are fit for the purpose. Theory might therefore be an obstacle to moving the field forward.

The purpose of our study is to reduce this knowledge gap by focusing on the theoretical development of the firm growth phenomena. While prior review studies on this topic in the entrepreneurship literature chiefly relied on traditional structured literature reviews, which have the potential to be biased (Rick Vogel & Güttel, 2013), our investigation uses bibliometric methods to dig deep into the theoretical foundations of firm growth. Bibliometrics is statistical analysis of scholarly communication through publications (Price, 1965). It uses citation patterns to analyze the domain and is able to mitigate researchers' biases associated with traditional literature reviews (Zupic & Čater, 2015). Our methodological approach enables us to quantitatively map current knowledge in the topic domain and thus complement prior reviews of firm growth. Specifically, our study reveals the theoretical foundations and underlying intellectual structure of the firm growth literature. The intellectual structure of a research stream includes the disciplinary composition of its research traditions, the topics they address, and the pattern of their inter-relationships (Shafique, 2013).

This chapter shows that resource-based theories are the dominant theoretical foundation of firm growth research. While this assumption has previously appeared in the growth literature (e.g., McKelvie & Wiklund, 2010), our analysis is the first to offer quantitative support for it. The second contribution is the division of the field into two large perspectives: strategic entrepreneurship and economics. We arrived at this division of the field's intellectual structure by using quantitative bibliometric methods that employ underlying citation practices of scholars that contribute to firm growth research. Authors from these two major streams of firm growth research have so far exhibited a limited scholarly discussion. We argue that, even though our delineation of intellectual structure confirms earlier findings about the fragmentation of firm growth research, the theoretical landscape has become less diverse in contemporary research than indicated in previous reviews. Our results reinforce calls from previous reviews (e.g. McKelvie & Wiklund, 2010; Wright & Stigliani, 2013) to reorient the focus of firm growth research from the antecedents of growth to new topics. Both major research streams would benefit from increased communication with each other.

2.2 Theoretical background

Edith Penrose (1959) discussed two main conceptualizations of firm growth. The primary meaning of firm growth implies an increase in size or improvement in quality as results of a

process of development. It is akin to natural biological processes in which an interacting series of internal changes leads to an increase in size accompanied by changes in the characteristics of the growing object (Penrose, 1959: 1). A secondary meaning of firm growth can simply denote an increase in an amount, such as growth in revenue or the number of employees. Firm growth as a phenomenon constitutes the very essence of entrepreneurship (Sexton, 1997) and has evolved over the years to become one of the most significant research topics. This has resulted in the broad and rich scope of firm growth research that is associated with numerous theoretical perspectives whose origins lie in economics, strategic management, sociology, and psychology. Several authors have produced exceptional review studies integrating the otherwise disparate literature on firm growth (Coad, 2009; Davidsson et al., 2010; Dobbs & Hamilton, 2007; Gilbert, McDougall, & Audretsch, 2006; Henrekson & Johansson, 2010; Levie & Lichtenstein, 2010; McKelvie & Wiklund, 2010; Wright & Stigliani, 2013).

2.2.1 Major challenges of growth research

Nevertheless, cumulative findings from the review studies suggest that progress has been limited. First, researchers have been unable to identify variables with consistent effects on growth across studies (McKelvie & Wiklund, 2010). Indeed, growth rates seem to be quite idiosyncratic and it has become increasingly clear that it is very difficult to generalize across firms' different experiences (Coad, 2009). This realization has led some researchers to hypothesize that growth rates are predominantly random (Coad, Frankish, Roberts, & Storey, 2013). The issue has been quite controversial, with dissenting researchers claiming that randomness is the artifact of the methods and that traditional methods have simply been unable to isolate those factors that would provide a deterministic order to the "illusion of randomness" (Derbyshire & Garnsey, 2014). Complexity science has been proposed as an alternative.

Second, different indicators of growth (e.g., revenue, employees) are only weakly correlated (D. Shepherd & Wiklund, 2009). They seem to identify different firms as high-growth (Coad, Daunfeldt, Hölzl, Johansson, & Nightingale, 2014). One possible implication is that different indicators are manifestations of various dimensions of the growth process and that studies using revenue growth or employment growth as indicators are not simply interchangeable. A theoretical implication is that different theories can explain different processes (Chandler, McKelvie, & Davidsson, 2009; Weinzimmer, Nystrom, & Freeman, 1998) and that theories should not be refuted if found unable to explain the growth of one indicator (D. Shepherd & Wiklund, 2009). Third, insufficient attention has been directed to differences among firms, industries, geographical and institutional contexts. The nature of growth is highly heterogeneous and multidimensional (Delmar et al., 2003). Studies that mix different industries and contexts might have difficulty obtaining clear results because the growth process might be driven by different factors in various contexts. More focused

investigations are thus required (Davidsson et al., 2010). Fourth, the majority of growth studies is based on cross-sectional data (Pugliese, Bortoluzzi, & Zupic, 2016), which are unable to depict causal relations among variables. The field definitely needs more longitudinal studies (Davidsson et al., 2006).

Finally, the limited theoretical advancement might be due to insufficient theorizing. Achtenhagen and colleagues (2010) could not identify clear theoretical foundations of half the studies they reviewed! But, even where theorizing is developed, there is little conversation among the different theoretical perspectives (Wiklund, Patzelt, & Shepherd, 2009). A notable exception is Chandler et al. (2009), a theory-driven study that clearly compares the applicability of two different theories for explaining growth. Further, the slow theoretical advancement could also be due to “theoretical misapplication” (Nason & Wiklund, 2015). Those theories inappropriate for explaining growth might be inspiring a disproportionate share of empirical investigations.

2.2.2 Theoretical explanations of firm growth

Very few studies explicitly review and discuss the theoretical foundations of firm growth. Coad (2009) put forward five theoretical perspectives: the neoclassical theory, the theory of the growth of the firm (Penrose, 1959), the managerial approach (Marris, 1964), evolutionary economics (R.R. Nelson & Winter, 1982), and population ecology (Hannan & Freeman, 1977). The neoclassical theory suggests that firms grow until they reach the optimal size. This is the profit-maximizing point where economies of scale are traded off against the cost of a large bureaucratic organization. Penrose, on the other hand, believed there is no a priori limit to firm size. In her alternative vision to neoclassical theory (Penrose, 1959), she viewed firms as collections of resources. Firm growth is led by internal momentum in which managerial resources are needed for expansion, but are then gradually released. These now unused resources become generators of subsequent growth, which exploits the productive opportunity set available to the firm. The availability of resources is the factor limiting the rate of growth, but not the size.

The managerial theory (Marris, 1964) proposes that managers themselves are interested in maximizing growth because along with firm size their compensation, power, and other perks increase. Managers are thus bound to grow their firms with the binding constraint being earning a satisfactory profit rate for the shareholders. Evolutionary theory (Aldrich, 1999; R.R. Nelson & Winter, 1982) applies the principle of ‘growth of the fitter’ for explaining firm growth. Fitter firms (i.e. more profitable, productive) survive and grow while less viable firms decline and exit. While the last four perspectives have their roots in economics, population ecology (Hannan & Freeman, 1977) comes from sociology. It places firms within a niche, which is the unit of analysis, not the firm. The growth of firms is then guided by the niche factors. For instance, if the niche resource pool is rich it will spur the growth of firms

in that niche until the resource pool is saturated, causing the firms to compete for these resources and in effect limiting their growth. Coad concludes that no single theoretical perspective can possibly explain firm growth – several theories must be employed to illuminate different dimensions of the growth phenomenon.

Coad's point of view is research on high-growth firms, which has its base in the discipline of economics. A different set of five perspectives was discussed by Wiklund, Patzelt and Shepherd (2009): resources, the entrepreneurial orientation, the environment, strategic fit, and growth attitude. Resource-based perspectives manifest in several variants ranging from Penrose's (1959) original resource theorizing to the modern Resource-Based View (RBV) (Barney, 1991) and its subsequent elaborations as dynamic capabilities (Teece, Pisano, & Shuen, 1997). Existing studies often do not take an explicit position on how they conceptualize their resources, but a recent meta-analysis established that Penrose's versatile resources are more appropriate for explaining firm growth than the RBV's VRIN resources (Nason & Wiklund, 2015).

The entrepreneurial orientation (EO) construct emphasizes risk-taking, innovativeness, and proactiveness in a firm's strategy. It reflects how a firm operates (Lumpkin & Dess, 1996). Previous research has linked EO to firm performance and growth. Each of the EO dimensions can have a positive effect on growth (Wiklund et al., 2009). The environment perspective proposes that the number and quality of growth opportunities is determined by the environment. The strategic fit perspective puts the strategic orientation in context and is in this sense an amalgam of the previous two perspectives. It claims that a firm that wants to grow needs to achieve a fit between its strategy and the environment. The growth attitude perspective recognizes that not all entrepreneurs want their companies to grow. Some prefer to keep their operation small because they expect less control and more problems with a bigger size (Wiklund, Davidsson, & Delmar, 2003) or wish to spend their time doing things they like instead of managing employees (Parry, 2010).

The stages of growth paradigm borrows organismic development from biology and applies it to the growth and development of firms. It was the most common approach to researching firm growth during the 1980s and 1990s (Levie & Lichtenstein, 2010). The main assumption of this approach is that organizations grow similarly to developing organisms (Phelps, Adams, & Bessant, 2007) through various stages (e.g., birth, growth, decline, death). In their review, Levie and Lichtenstein (2010) traced the origins of stage models to five theoretical foundations: evolution/revolution (Greiner, 1972), stages of corporate development, morphogenesis, the organizational life cycle (Miller & Friesen, 1984), and the product life cycle (PLC). Greiner's model is the most used as a foundation, but most of the stage models use a mixture of these origins. Despite decades of research, the stage models received limited

empirical support and the conclusion was that they are “not appropriate for understanding firm growth” (Levie & Lichtenstein, 2010).

This brief review shows that numerous theories have been used to explain growth. However, we do not know which of them are actually used in contemporary research and how influential they are. Review authors have complained about the lack of theoretical development and suggested that new theories are needed to advance the knowledge (Dobbs & Hamilton, 2007). A rigorous analysis of the intellectual structure of the body of literature on firm growth is needed to unveil the theoretical foundations of firm growth research in order for the field to advance.

2.3 Data and methods

We used the bibliometric methods of citation and co-citation analysis to examine the theoretical foundations of the firm growth literature. Bibliometric methods assume that citations are an important indicator of communication among scholars (Gmür, 2003). If a specific publication is cited, it is assumed that it has influenced the research which is referencing this publication. The number of citations can thus be used as a measure of influence. Bibliometric analyses use quantitative bibliographical data to complement the expert reviews of specific scientific fields (Nerur, Rasheed, & Pandey, 2016). In a sense, they aggregate the views of many researchers who voice their opinion through citation in published studies.

To examine the intellectual structure of the firm growth research we used co-citation analysis. Co-citation analysis was first developed by Small (1973) and is now the most frequently used method in bibliometric studies (Zupic & Čater, 2015). The workings of co-citation can be explained with the following mechanism. When two publications are cited in the same original study, it is highly probable that these two publications are connected. If they are cited together multiple times, the link becomes stronger and the probability that these publications belong to the same research stream increases. When we aggregate a large number of these links, we can draw networks of studies and apply dimension-reduction methods (e.g. clustering, principal component analysis, network grouping algorithms) to find the structure of research streams within the examined literature. Co-citation analysis is applied to studies cited by contemporary publications so it is especially appropriate for studying the intellectual structure of theoretical foundations.

Bibliometric methods are increasingly gaining in acceptance. A recent study estimated that more than half of all bibliometric studies in management and organization were published in the last three years (Zupic & Čater, 2015). This is the result of the proliferation of easily accessible online databases that contain citation data as well as the availability of bibliometric software for analysis. Several bibliometric studies of entrepreneurship literature

were published in recent years. Landström, Harirchi, & Åström (2012) conducted a thorough bibliometric analysis of the knowledge base of the entrepreneurship field. Wallin (2012) examined the intellectual structure of spin-off literature, Cornelius and Persson (2006) focused on the foundations of venture capital research while several studies researched the structure of family business research (Casillas & Acedo, 2007; Chrisman, Kellermanns, Chan, & Liano, 2009). One of the first comprehensive bibliometric assessments of the entrepreneurship field was a special issue of *Entrepreneurship Theory & Practice* (Gartner et al., 2006) which published four bibliometric papers that thoroughly examined the entrepreneurship literature. More recently, Busenitz and colleagues (2014) used bibliometrics to find that entrepreneurship studies are now significantly present in “A” journals. To the best of our knowledge, there has not been any previous bibliometric study on the topic of firm growth in entrepreneurship.

2.3.1 Data

The Social Science Citation Index (SSCI) is the citation database most used in bibliometric studies (Zupic & Čater, 2015). SSCI data are accessible through the Thomson Reuters Web of Science (WOS) online database. We searched WOS for »firm growth« OR »startup growth« OR »venture growth« in the title, abstract or keywords of searchable documents published between 2003 and 2014, which returned 10,536 results. We further limited the set to the »Management« and »Business« categories, with 3,668 results remaining. We limited the time span to documents published since 2003. We choose 2003 as the cutoff year for two reasons: our aim was to examine the theoretical foundations of contemporary research, so roughly ten years of the research study sample was appropriate for our intentions and it is the year when the landmark study “Arriving at the high-growth firm” (Delmar et al., 2003) was published.

Our journal selection aimed to support two aims: we wanted to include a broader debate than is present in just the top-tier journals. However, to ensure high standards of research rigor we only chose papers published in high-quality entrepreneurship journals. To determine these, we used the Association of Business Schools (ABS) journal list, which is frequently referred to for hiring and tenure decisions at European business schools. The ABS list is also used by the British Research Excellence Framework (REF) to assess the quality of research in UK higher education institutions. We decided to use journals with an entrepreneurship specialty with ABS grade 3 or more (*Entrepreneurship Theory and Practice, Journal of Business Venturing, Small Business Economics, International Small Business Journal, Entrepreneurship and Regional Development, Journal of Small Business Management, and Strategic Entrepreneurship Journal*) and top management journals (*Academy of Management Review, Academy of Management Journal, Strategic Management Journal, Journal of Management, Journal of Management Studies, Management Science and Organization Science*). As one of the main quality outlets for firm growth research, the

Industrial and Corporate Change Journal was added to the list. Applying these criteria limited the results to 1,192 articles.

We read every abstract of these papers and only included those that studied firm growth (in any of its variants – sales growth, employee growth) as one of the studied constructs. A number of papers studied firm performance. If any of the papers used the term »new venture performance« we automatically included the study in the set because new ventures cannot perform without growth. If the paper studied older firms, we checked whether any kind of growth was used as a measure of performance. We excluded those entrepreneurship studies primarily concerned with economic growth and not firm growth, although often these issues are very interrelated. Therefore, in cases where studies explored the role of firm growth in the context of economic growth, we opted to keep those publications in the set. We included all studies that had various manifestations of firm growth as one of the studied variables, so our sample of publications is broader than in earlier reviews of firm growth research. Thus, our account includes some studies that are not normally considered to be part of the firm growth research stream, but inform and enrich our knowledge about the phenomenon. After this selection process, 422 publications remained that constitute our core document set.

2.3.2 Analysis

When the final data set was compiled in the WOS web application, we exported the citation data from WOS and imported it into the Bibexcel bibliometric software (Persson et al., 2009) to conduct the bibliometric analysis. Cleaning the data is an important step in bibliometric analysis. Citation data retrieved from Web of Science contain inconsistencies: journal names can have different abbreviations, authors with middle names can have slightly different representations and authors with common surnames must be disambiguated. We cleaned the data to remove these inconsistencies.

The first step after cleaning was to conduct citation analysis. We identified the most cited documents and the most cited authors. Second, to define the structure of the theoretical foundations we performed co-citation analysis on the references cited by the core document set. We calculated the co-citation matrix (which represents co-citation counts for each pair of cited studies) and exported the data to the Pajek network analysis software (Batagelj & Mrvar, 1998) for visualization and further analysis. We used the Kamada-Kawai algorithm for visualizing the network graphs.

The co-citation network was further analyzed in the Pajek network analysis software with the Islands algorithm to find groups of cited references. It is helpful to illustrate the functioning of the Islands algorithm with a mountain range submerged in water (in our case the height of the mountains represents co-citation strength). When the water is drained, the highest peak appears as an island first as lower peaks gradually emerge. These islands

represent clusters of highly co-cited publications. An important advantage of this algorithm is that it functions well on co-citation matrices because it can accommodate network subgroups with internal links of different strength. In our case, we have groups of publications with varying degrees of citation intensity. This algorithm enables less cited groups of publication to be revealed. In summary, a group of publications represents a peak within a mountain range where co-citation links within-group are stronger than those with out-of-group publications.

The final step in our analysis included identifying contemporary publications that cited each theoretical group. To identify the citing publications, we imported the citation data into the SQL database. We used SQL queries to find publications responsible for at least one co-citation link in each group (i.e. simultaneously citing at least two publications in the group). By doing this, we were able to reveal current research questions and practices for each subgroup of theoretical foundations of firm growth research.

2.4 Results

We report the results of the bibliometric analysis in two sections. The first section summarizes the citation analysis of firm growth research to determine its most influential journals, documents, and authors. The second section reports our findings regarding the intellectual structure of theoretical foundations of firm growth research. With these two approaches we were able to identify the main theoretical traditions in which the research on firm growth is anchored.

2.4.1 The most influential journals, documents, and authors

The most influential outlets for firm growth research are identified in Table 7. It shows journals ranked by the number of articles published. *Small Business Economics* tops the list with 112 publications. This is followed by *Journal of Business Venturing* (54 papers), *Journal of Small Business Management* (38) and *Entrepreneurship Theory & Practice* (37).

Table 7. Journals in the sample that published high-growth research

Journal	No. Pub.
SMALL BUSINESS ECONOMICS	112
JOURNAL OF BUSINESS VENTURING	54
JOURNAL OF SMALL BUSINESS MANAGEMENT	38
ENTREPRENEURSHIP THEORY AND PRACTICE	37
STRATEGIC MANAGEMENT JOURNAL	30
INTERNATIONAL SMALL BUSINESS JOURNAL	28
INDUSTRIAL AND CORPORATE CHANGE	26
JOURNAL OF MANAGEMENT STUDIES	17
ORGANIZATION SCIENCE	16
ENTREPRENEURSHIP AND REGIONAL DEVELOPMENT	16
ACADEMY OF MANAGEMENT JOURNAL	13
MANAGEMENT SCIENCE	13
STRATEGIC ENTREPRENEURSHIP JOURNAL	12
JOURNAL OF MANAGEMENT	8
ACADEMY OF MANAGEMENT REVIEW	2

The most cited documents are summarized in Table 8. The Theory of the Growth of the Firm by Edith Penrose (1959) is with 86 citations the most cited publication by 422 articles in our sample. This seminal contribution is followed by foundational work on the resource-based view (RBV) (Barney, 1991) and its early empirical test (Cooper et al., 1994). The top three most cited documents are thus resource-based foundations of growth. Ten publications on the list were published in economics journals (e.g., Evans, 1987a; Jovanovic, 1982). The most recently published document with the highest yearly rate of citations is Delmar et al. (2003).

Table 8. Top cited documents with 24 or more citations.

Cited document	No. cit.
Penrose E, 1959, Theory Growth Firm	86
Barney J, 1991, V17, P99, J Manage	66
Cooper A, 1994, V9, P371, J Bus Venturing	57
Delmar F, 2003, V18, P189, J Bus Venturing	56
Storey D. J, 1994, Understanding Small	55
Nelson R, 1982, Evolutionary Theory	52
Shane S, 2000, V25, P217, Acad Manage Rev	47
Sutton J, 1997, V35, P40, J Econ Lit	46
Cohen W, 1990, V35, P128, Admin Sci Quart	44
Evans D, 1987, V35, P567, J Ind Econ	39
Jovanovic B, 1982, V50, P649, Econometrica	38
Eisenhardt K, 1990, V35, P504, Admin Sci Quart	38
Gimeno J, 1997, V42, P750, Admin Sci Quart	37
Evans D, 1987, V95, P657, J Polit Econ	37
Porter M. E, 1980, Competitive Strategy	34
Wernerfelt B, 1984, V5, P171, Strategic Manage J	31
Heckman J, 1979, V47, P153, Econometrica	30
March J, 1991, V2, P71, Organ Sci	29
Caves R, 1998, V36, P1947, J Econ Lit	29
Baum J, 2001, V44, P292, Acad Manage J	29
Dunne P, 1994, V42, P115, J Ind Econ	28
Weinzimmer L, 1998, V24, P235, J Manage	28
Teece D, 1997, V18, P509, Strategic Manage J	27
Davidsson P, 2003, V18, P301, J Bus Venturing	27
Lumpkin G, 1996, V21, P135, Acad Manage Rev	27
Hall B, 1987, V35, P583, J Ind Econ	27
Shane S, 2000, V11, P448, Organ Sci	26
Geroski P, 1995, V13, P421, Int J Ind Organ	25
Schumpeter J, 1934, Theory Ec Dev	25
Kogut B, 1992, V3, P383, Organ Sci	25
Stinchcombe A, 1965, P142, Hdb Org	25
Aldrich H, 1999, Org Evolving	24
Dunne T, 1989, V104, P671, Q J Econ	24
Covin J, 1989, V10, P75, Strategic Manage J	24
Granovetter M, 1985, V91, P481, Am J Sociol	24

A similar but slightly different picture is painted by the list of most cited first authors. Per Davidsson is the most cited author in firm growth research with 194 citations, followed by David B. Audretsch with 182 citations. Several well-known entrepreneurship authors follow: Shaker Zahra, Scott Shane, and Kathleen Eisenhardt. The first two did not contribute specifically to growth research, but were highly cited due to their contributions to social capital theory and debates about entrepreneurship scholarship. Kathleen Eisenhardt was a pioneer of firm growth research (Eisenhardt & Schoonhoven, 1990) and is one of the main

sources of methodological advice on qualitative research (Eisenhardt, 1989). Authors with more than 120 citations also include: Johan Wiklund, David Storey, Edith Penrose, Arnold Cooper, and Frédéric Delmar. Because only information about cited first authors is included in the SSCI citation data, the contribution of second authors could be underestimated.

2.4.2 The structure of the theoretical foundations of firm growth research

The Islands algorithm identified ten groups that form the intellectual structure of the firm growth research. Two large groups emerge as the main theoretical foundations. The first group contains major works in strategy and entrepreneurship centered around Penrose and the RBV and includes 26 publications that are widely cited by the authors of growth studies. The second group is anchored in economics and includes 18 publications. The remaining eight groups are smaller and include three to seven knowledge base publications. For each group, we briefly discuss the identified group of theoretical foundations and contemporary studies that are citing this group.

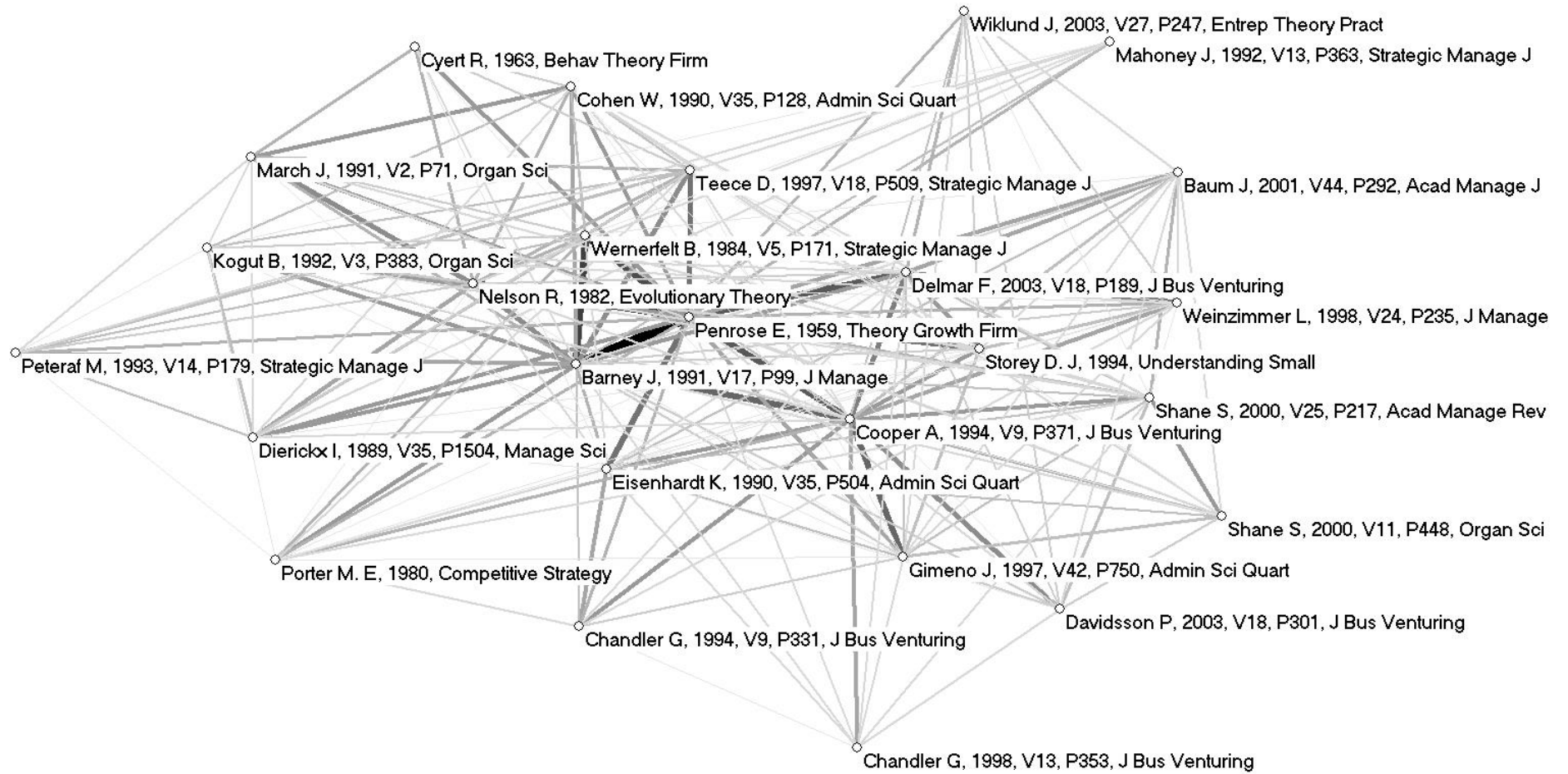
Strategic entrepreneurship

The largest knowledge base group contains the most cited publications in firm growth research. We labeled it strategic entrepreneurship since it contains the foundational works from strategy and entrepreneurship. It includes two subgroups of publications. The left part of the network graph (Figure 15) features the most prominent theoretical perspectives that inform firm growth research. The right part contains research papers specific to entrepreneurship, most of them are early empirical studies of firm growth. The central publication in the group is Penrose's *Theory of the growth of the firm* (1959). The theory significantly contributed to the emergence of the resource-based view (RBV) perspective in management (Barney, 1991; Wernerfelt, 1984). The RBV then gave rise to prominent spin-off perspectives, such as the knowledge based view (Kogut & Zander, 1992) and dynamic capabilities (Teece et al., 1997). The remaining significant theoretical perspectives in this group include behavioral theory (Cyert & March, 1963), evolutionary theory (R.R. Nelson & Winter, 1982), the absorptive capacity perspective (W. M. Cohen & Levinthal, 1990), and Porter's modern version of the Structure-Conduct-Performance paradigm (M E Porter, 1980).

The right part of the network graph mostly contains empirical studies of firm growth in entrepreneurship. The strongest connections with the theoretical foundations in the left part of the network graph are through two publications: Cooper et al. (1994) and Delmar et al. (2003). These two publications hold great historical importance in development of the field. Cooper et al. (1994) performed one of the earliest tests of various resources' (e.g. human capital) contribution to firm growth and was thus hugely influential. Roughly a decade later,

Delmar et al. (2003) sparked additional interest in firm growth by showing the heterogeneous nature of the growth process.

Figure 15. Co-citation network – strategic entrepreneurship group.



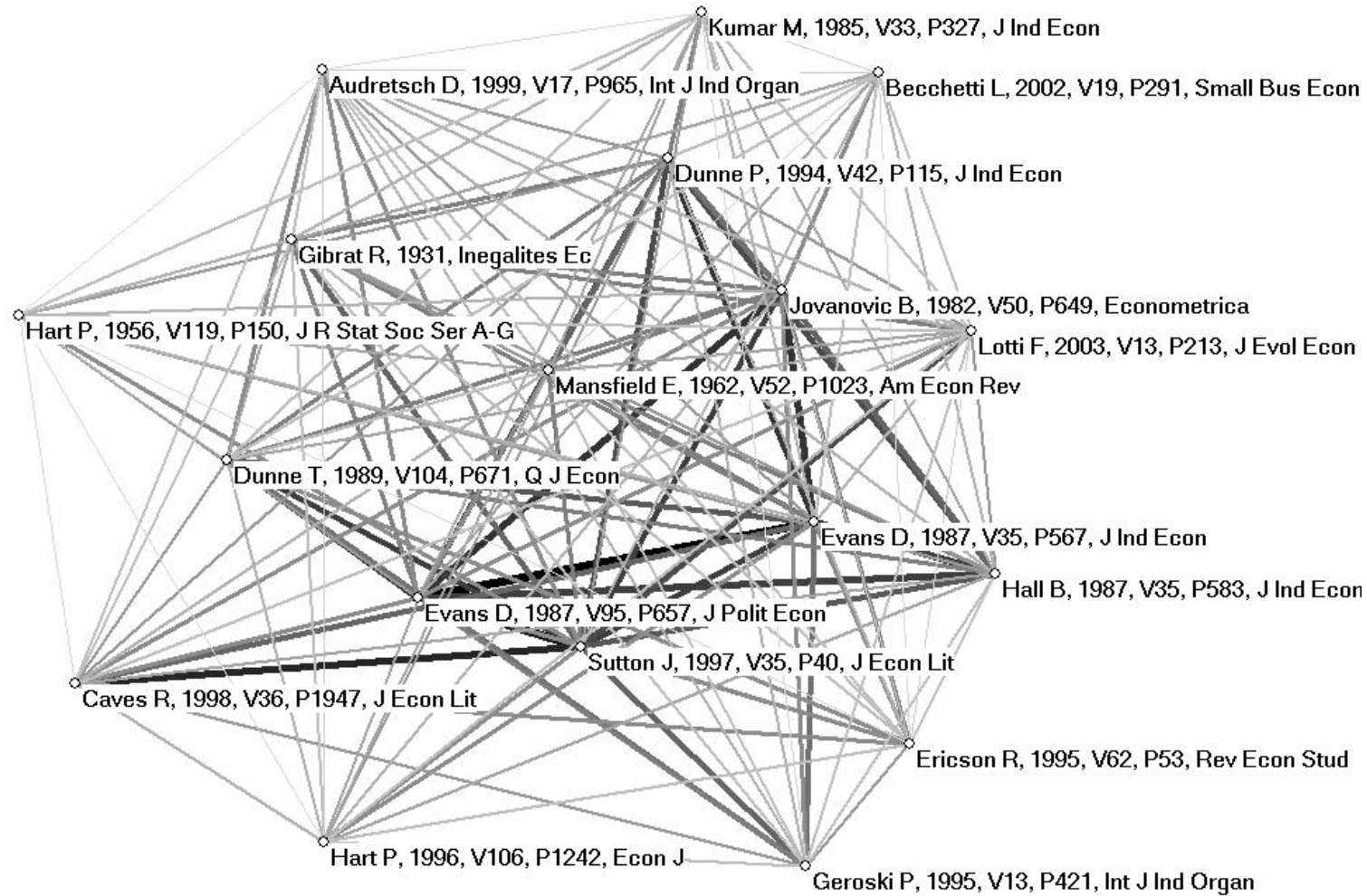
Economics

The second biggest group includes 18 publications that are strongly interconnected by co-citation linkages and mostly published in economic journals (Figure 16). The main topic of this literature is the research on High-Growth Firms (HGFs).

A large number of empirical publications questions whether firm growth is independent of firm size by building on the conceptual perspectives of Gibrat's law (Gibrat, 1931). Due to the inconsistent empirical findings, there have been considerable controversies regarding the relevance of Gibrat's law (Evans, 1987b; Jovanovic, 1982; Lotti, Santarelli, & Vivarelli, 2003). Recently, empirical findings have found contra to Gibrat's law that firm growth rates seem to be negatively correlated with firm size; moreover, the relationship between firm size and firm growth is nonlinear (Bonaccorsi & Giannangeli, 2010; Stam, 2010). Nevertheless, it seems that researchers of firm growth that build on foundations in economics tend to see the randomness of firm growth implied by Gibrat's law as a reasonable first approximation when thinking about firm growth (Coad, 2009).

Most studies citing this knowledge base cluster are published in two journals: *Small Business Economics* and *Industrial and Corporate Change*. Articles in this group most often use sophisticated quantitative methods to find stylized facts about firm growth by examining large-scale databases and surveys. The findings of this research to date were succinctly summarized by Coad, Daunfeldt, Hölzl, Johansson, and Nightingale (2014). The established stylized facts hold that a small number of HGFs are creating a disproportionately large number of jobs. HGFs tend to be young, but not necessarily small and are not more common in high-tech industries, as is often believed. High growth is difficult to predict and is not persistent. Different indicators (e.g., sales, revenue) select different firms as HGFs.

Figure 16. Co-citation network – Economics foundations group.



Entrepreneurial orientation

Entrepreneurial orientation (Lumpkin & Dess, 1996; Miller, 1983) has been recognized as one of the most robust determinants of firm growth (Wiklund et al., 2009). Entrepreneurial orientation (EO) refers to a strategic orientation of an entrepreneurial firm that includes innovating to rejuvenate market offerings, taking risks in order to try out new and uncertain products, services and markets, and proactiveness in engaging with competitors while vying for new market opportunities (Covin & Slevin, 1989; Wiklund & Shepherd, 2005).

Of the publications citing this knowledge base group, Moreno & Casillas (2008) found that the EO–growth relationship is positive, but they also revealed the complexity of relationships between EO, strategy, environment, and growth. Other studies have also shown that entrepreneurial management enables growth, but financial slack resources reduce entrepreneurial behavior (Bradley, Wiklund, & Shepherd, 2011).

Entrepreneurial networks

The network perspective in firm growth research assumes that networks are an important resource of an entrepreneurial firm. It is one of the most important theoretical perspectives in the debate on entrepreneurship. Publications in this group examine how personal, inter-firm, and intra-firm networks shape firm growth. They are used productively in achieving success with firm growth (Brüderl & Preisendörfer, 1998). Social capital can also be a way for entrepreneurs to compensate for a lack of other forms of capital (e.g. human, financial).

Contemporary empirical studies have emphasized that inter-firm networks are the most valuable source of growth for new ventures (Lechner & Dowling, 2003). Different types of networks (e.g. reputational, marketing, innovation, co-opetition networks) are more or less important at different stages of a venture's life-cycle. For instance, an entrepreneur's social networks help to overcome the lack of legitimacy when starting a new business (Elfring & Hulsink, 2003), but later diminish in importance. Reputational networks help build future ties – a lack of reputational networks is a significant obstacle to growth. Firms need to develop a different network mix at each development stage to overcome these constraints (Lechner, Dowling, & Welp, 2006).

Finance

The four publications in this group are some of the best known contributions to the development of the finance literature (e.g. Modigliani & Miller, 1958). This stream of research is concerned with the effects of capital structure on new venture performance (Michaelas, Chittenden, & Poutziouris, 1999).

Contemporary studies investigate the interplay between firm financing and growth. They examine ways in which startups use various types of financing (Cassar, 2004), credit

constraints faced by new technology-based firms (Colombo & Grilli, 2006), the growth-cycle theory of small business financing (Gregory, Rutherford, Oswald, & Gardiner, 2005), and how bootstrapping new ventures affects their growth (Vanacker, Manigart, Meuleman, & Sels, 2011).

Internationalization

The internationalization group is the largest among the smaller groups. Internationalization is increasingly recognized as one of the most important modes of growth for new ventures (Davidsson et al., 2010). Tension between the stages model of internationalization (Johanson & Vahlne, 1977) and international new venture theory (McDougall, Shane, & Oviatt, 1994; Oviatt & McDougall, 1994) is visible in this cluster. International new venture theory states that ventures which begin their international expansion early (as opposed to gradual international expansion implied by the stage model) are more successful.

Organizations adapt to the uncertainty and risk of internationalization by generating new capability for international entry (Sapienza, Autio, George, & Zahra, 2006). Exposure to internationalization gives organizations the flexibility to pursue opportunities for growth and increases organizations' productive opportunity set.

Options and uncertainty

In a dynamic environment the future is unforeseeable so entrepreneurs seek to »keep their options open« (Bowman & Hurry, 1993). Joint ventures are one of the forms firms take to deal with future technological and market developments (Kogut, 1991). They could be viewed as growth options and valued accordingly (McGrath, 1997).

The real options approach has been used to analyze firms' investment under uncertainty (Tong & Li, 2011). Firms often invest in new and uncertain markets that are viewed as strategically important but inherently risky – such investments can be viewed as options on the future. Options are a useful approach when firms have to decide on a specific mode of growth when facing uncertainty: acquisitions, corporate venture capital investments (CVC), alliances, or joint ventures. As uncertainty is a major feature of dynamic environments, this cluster is related to the cluster on the organizational environment.

Institutions

Institutions represent society's rules of the game and determine what kind of activity people will engage in. They can be both formal (e.g. laws) or informal (e.g. codes of conduct). Baumol (1996) cites several historical examples of society's rules and institutions determining whether entrepreneurs will pursue productive or unproductive activity while amassing wealth. It is in common interest to steer entrepreneurs into doing things that increase societal welfare. When formal institutions that function impersonally are not

developed, entrepreneurs seek protection from personal contacts and social networks. These manifest as informal institutions. A good example is China's Guanxi (Xin & Pearce, 1996). The functioning of institutions can explain the differences in the performance of entire economies (North, 1990).

Contemporary publications in this cluster examine how institutions shape entrepreneurs' behavior. These studies are geographically very diverse. Authors have shown a particular interest in Chinese entrepreneurs (e.g. Zhao, Frese, & Giardini, 2010) as well as their American, Russian, and Indonesian counterparts. Several studies made cross-country comparisons (e.g. Batjargal et al., 2013). The influence of institutions on entrepreneurship, however, is not just a one-way street: entrepreneurs can shape institutions too. The research stream on institutions is of great interest to policymakers tasked with generating the design of an institutional environment intended to support high-growth firms. This group of studies is loosely connected with two other clusters: entrepreneurial networks and organizational environment.

HR management

Even though the vast majority of businesses are small and medium-sized, most research in human resource management (HRM) tends to focus on large firms (Hornsby & Kuratko, 1990). Yet it could be argued that for small growing firms HRM is even more important as each individual's contribution to firm performance is proportionally greater. The human capital of employees can be enhanced by investing in their knowledge and skills. Strategic HRM takes the contingency perspective to examine the notion of a »fit« between various HR practices and their influence on organization-level performance. For example, High Performance Work Systems (Huselid, 1995) have been linked with increased performance.

Studies citing this group show that SMEs begin using diverse formal HR practices early on in the growth process (Kotey & Slade, 2005). The human capital of both the founders and employees needs to be coupled with its development and utilization (Rauch, Frese, & Utsch, 2005). Human resources are an important predictor of the growth of SMEs. Carlson, Upton, & Seaman (2006) found that training and development, maintaining morale, competitive compensation, and other HR practices were more important for high sales-growth companies than low-growth ones. Finally, Messersmith & Wales (2011) established that firms with a high Entrepreneurial Orientation (EO) benefited from the implementation of high-performance work systems (HPWS) more than their low-EO counterparts and thus realized higher sales-growth rates.

Organizational environment

Characteristics of the organizational environment heavily influence the amount and modes of firm growth. Three publications that form the theoretical base of this cluster aim to

connect various dimensions of the environment with venture performance. Dess and Beard (1984) proposed three dimensions of organizational environment: munificence, complexity, and dynamism. The munificence concept states that organizations seek environments that enable them to grow and generate slack resources that allow the organization to survive periods of scarcity (Cyert & March, 1963). Dynamism represents both turbulence of the environment and the stability-instability axis. Highly dynamic environments are characterized by unpredictable change and heightened uncertainty. This dimension receives most of the attention in research front articles of this cluster. Environmental complexity refers to the heterogeneity and range of activities organizations need to perform (Child, 1972). These dimensions are the product of a long history of theoretical development and empirical research (Keats & Hitt, 1988). Arguments of how the environment affects organizations are theoretically based on population ecology (Hannan & Freeman, 1977) and resource dependence theory (Pfeffer & Salancik, 1978).

The consistent theme in this cluster is decision-making under the uncertainty of dynamic environments. Recently, Baum and Wally (2003) explored strategic decision speed and firm performance under different combinations of organizational and environmental characteristics. Other studies examined entrepreneurs' growth intentions as they change through time in different competitive conditions (Dutta & Thornhill, 2008), scrutinized the moderating influence of environmental dynamism on the relationship between leadership behavior and venture performance (Ensley, Pearce, & Hmieleski, 2006), entry modes when internationalizing (Rasheed, 2005), and opportunity exploitation in conditions of risk and uncertainty (Hmieleski & Baron, 2008).

2.5 Discussion and conclusion

The main finding of our analysis is that resource-based theorizing (Barney, 1991; Penrose, 1959; Wernerfelt, 1984) is the most influential theoretical perspective on firm growth. We believe that the reason leading to this development is associated with the predominant tendency of firm growth researchers to examine the antecedents of firm growth. Focusing on antecedents aims to explain variances in growth rates among firms. This line of thinking tries to relate a wide spectrum of firm resources and capabilities to growth. Our analysis reveals just how dominant the resource-based explanations of growth have become. This domination shows that the diversity of theories used to explain growth has decreased. Even though the field of firm growth is still fragmented, the theoretical foundations are arguably less diverse. It looks as if the resource-based theories have crowded out other theoretical foundations of growth.

We identified ten groups of publications that form the intellectual structure of the firm growth research. Two groups are larger and more influential than the others. The first group builds on the resource-based perspectives and relates the micro and macro level resources of a firm to its growth. In contrast, the second large group of publications is grounded in

economic foundations of firm growth and is mainly empirical and atheoretical. The eight smaller groups are less influential. We do not argue that our structure of the field is somehow more “correct” than those established by previous reviews. As Davidsson and colleagues (2010) noted, it is notoriously difficult to arrive at a sensible classification of literature. However, our categorization is based on the citation practices of firm growth research authors and thus reflects the aggregate views of those authors.

Coad (2009: 100) identified five theoretical perspectives that inform firm growth research: neoclassical economic theory, Penrose's “Theory of the growth of the firm”, the managerial approach, evolutionary economics, and population ecology. Findings from our co-citation analysis indicate that the neoclassical economic theory and managerial approach have not frequently been used as theoretical foundations for explaining firm growth. On the other hand, the “Theory of the growth of the firm”, evolutionary economics, and population ecology, as identified by Coad (2009), constitute important theoretical foundations of the field. Penrose's (1959) book is the most heavily cited publication in firm growth research. It strongly influenced the emergence of the RBV and it is the leading theoretical foundation associated with the biggest knowledge base group of firm growth research identified in our co-citation analysis. The arguments of evolutionary economics theory (R.R. Nelson & Winter, 1982) also appear in the largest group of the intellectual structure and in the list of the most cited documents. Population ecology arguments (Hannan & Freeman, 1977) are represented to a much smaller extent in smaller groups of publications (e.g. the group of organizational environment) but are not cited frequently enough to be included in the most cited publications list in Table 2. This is consistent with the observation that the field has moved from theories that treat firms as equals towards theories that treat firms as being unique and heterogeneous (Davidsson et al., 2010).

Our results are also partially congruent with the five theoretical perspectives identified by Wiklund et al. (2009): resources, the entrepreneurial orientation, the environment, strategic fit, and growth attitude. As already mentioned, the resource perspective is the most influential while the entrepreneurial orientation and the environment were two of the co-citation groups identified by our algorithm. We did not find evidence of the strategic fit and growth attitude perspectives.

Another striking feature of our results is the missing research on the growth process. The growth process is usually part of literature reviews on firm growth, but contemporary research is close to non-existing. We are not the first to notice that process studies are underrepresented (e.g. Davidsson et al., 2010), but the quantitative confirmation of this fact and the extent of the dominance of the resource-based foundation of growth studies are worrying. The stages of growth literature was heavily criticized. The dynamic states approach was proposed to remedy the shortcomings of the stages of growth perspective

(Levie & Lichtenstein, 2010), but researchers have not yet picked up on these proposals with new studies.

2.5.1 Implications and future research suggestions

It increasingly seems that the antecedents of growth literature has exhausted itself and new paradigms are needed. We estimate that the antecedents of growth research has hit a similar wall to that of stage models and is in danger of a similar fate of a future decline. Scholars need to find growth explanations beyond those based on the RBV. We outline a plan to reinvigorate firm growth research by developing the implications of our findings and building on research suggestions by authors of previous reviews.

The first possibility is to go back to the original Penrose work on resources as advocated by Nason and Wiklund (2015). Penrose's insights are not an unreasonable starting point for scholars since the theory has performed so well over time. Specifically, researchers should focus on the versatility of resources, which is the characteristic applicable to growth, as opposed to VRIN resources, which is the characteristic applicable to creating a competitive advantage and capturing rent streams. Penrose is considered an important precedent to the RBV, but there is relatively little work that engages deeply with her ideas (there are some exceptions, e.g. Lockett, Wiklund, Davidsson, & Girma, 2011). Further, the scope of Penrose's theory was industrial (manufacturing) firms. The question is whether the theory still applies to contemporary digital enterprises? Are rapidly growing firms like Google, Snapchat, and Uber still held back by the lack of available skilled managers? Are the 'Penrose effects' still relevant?

Second, demand-side considerations have been neglected in the debate on firm growth. We think that theoretical development is held back by the disciplinary nature of inquiries. It is the interaction among resource configurations and customer demand that fuels growth. We believe the business model construct with its integration of the value creation and value capture perspectives is the right avenue for taking this investigation forward because it can bridge the disciplinary divide between strategic entrepreneurship and marketing. The first pioneering studies about the connection of business models and growth have been published (Chandler, Broberg, & Allison, 2014), but more are needed.

Third, even though the process of development is one of the two main definitions of growth, empirical investigations and theoretical elaborations of the growth process have become rare. This is an area that cannot be neglected any more. Since the stages approach has been discredited, new paradigms are needed that will take the sound parts of the stages approach and build the growth process research on a more rigorous basis. Complexity science might be the theoretical perspective supporting such an approach (Derbyshire & Garnsey, 2014; Levie & Lichtenstein, 2010).

Fourth, using the RBV as a theoretical foundation tends to produce simplistic characterizations of the complex process that the growth phenomenon in reality is. Recent RBV literature emphasizes that not only possession but the utilization of resources is extremely important. If researchers want to stay within the RBV boundaries, they need to focus on how the resources actually become utilized for growth.

Fifth, the research stream with foundations in economics has amassed a considerable number of stylized facts about high-growth firms. The empirical part of this research stream is doing well and is benefitting from the increasing quality and availability of data. But the final aim of this kind of research is to inform policy. However, the policy implications of the empirical results remain elusive. What can governments really do to support HGFs? What will this ‘support’ actually look like in concrete terms? If high growth is not persistent and virtually impossible to predict ex-ante, which firms should be targeted? Will supporting high-employment growers encourage unproductive firms to grow? There are many important questions about policy implications that remain unanswered.

We end the suggestions for future research with a call for greater integration of the two main streams of firm growth research. The strategic entrepreneurship and economics streams of firm growth research have so far developed in relative isolation. We believe scholars on both sides of the divide have much to gain from increased communication. It would be a pity to miss this opportunity. However, bridging disciplinary divides is inherently difficult as different disciplines use different research methods, assumptions and theories (Molloy, Ployhart, & Wright, 2011). One possible strategy could be “theory borrowing”, where researchers in one discipline base their research on theories more common in other discipline. Another strategy would be building large-scale datasets that follow cohorts of firms over time and use standardized questionnaires. This would allow using economics-based methods on data collected with validated measures. However, the necessary effort and cost of such projects might prohibit wider application of this strategy.

2.5.2 Limitations

Bibliometric methods have several well-known limitations. They do not capture the context and the intentions of the citing authors (Vogel & Güttel, 2013). In one case, a particular article can be cited as an important source that influenced the thinking process of the author and, in another, it could be cited solely by the author as material worth refuting. Authors tend to cite important seminal work by routine, ritual citation without always engaging with the source material (Garfield, 1979).

Some of the groups could be small due to our scope limitations when selecting our data sample as we limited the search to top management and entrepreneurship journals. For instance, growth financing is likely researched in greater detail in the finance literature, likewise institutions are a major topic within the economic development and growth literature. The Islands algorithm – our grouping method – could have missed some smaller

clusters without clear co-citation boundaries. It is possible that these could go undetected. We also deliberately chose to analyze the theoretical foundations of contemporary research published since 2003. Theoretical traditions that were used before that period and subsequently faded were not part of our analysis.

2.5.3 Conclusion

Firm growth research is alive and well. Our bibliometric analysis unveiled a plethora of research streams and theoretical perspectives that offer significant opportunities for future research. Building on the wealth of empirical investigations into growth phenomena, we offered several suggestions for future research directions. We have no doubt that entrepreneurship scholars are already working on some of the topics suggested. Finally, we hope that our analysis will spark additional interest in some under-researched topics, which will enhance knowledge about the diverse phenomena of firm growth.

3 BARRIERS TO THE GROWTH OF HIGH-TECH FIRMS

The barriers to growth literature has been criticized for being underdeveloped and undertheorized. We conceptualize barriers to growth as firm-level factors that are necessary conditions for growth. There are five barriers to growth: finance, human capital, growth ambition, growth management knowledge, and product-market fit. The necessary conditions logic demands that all conditions must be met if the firm is to grow. Our conceptualization is based on 32 interviews with technology entrepreneurs, investors, and support-institution representatives, data from a 3-month observation of a startup batch in a venture accelerator, and the existing literature. We contextualize barriers in Spigel's (2015) model of the entrepreneurial ecosystem by specifying how the conditions for barriers on the entrepreneurial ecosystem level influence barriers on the firm level.

3.1 Introduction

What is holding back the growth of high-tech companies? One of the most consistent findings of research on high-growth firms (Alex Coad et al., 2014) is that high growth is not persistent. Firms typically – if they grow at all – grow in bursts and very rarely manage to persistently grow over a longer period of time. One assumption about why this happens is that certain internal and external factors prevent the growth of new ventures. A long list of factors has been proposed as constraints on the growth process: finance (e.g. lack of access to credit), institutional factors (e.g. bureaucracy, complicated regulations, corruption), lack of various skills (e.g. management skills), or lack of resources. These factors are usually viewed as barriers to growth.

But what exactly are ‘barriers to growth’? The concept has been criticized as vague. The barriers to growth literature is fragmented and theoretically underdeveloped (Doern, 2009). Existing studies are based on quantitative surveys with theoretically weakly founded questionnaires. Methodological problems abound: overreliance on cross-sectional studies, absence of standardized measures of barriers, and the risk of retrospective bias. Bottazzi, Secchi, and Tamagni (2014) warned against using simplistic approaches like linear regression due to the complex interactions among factors. There is also an insufficient distinction from similar concepts. For example, sometimes barriers are mentioned as just the “mirror image” of growth drivers (Davidsson et al., 2010). Finally, some barriers – finance is the clearest example – can be viewed as both internal and external.

We solve this conundrum by invoking the entrepreneurial ecosystem concept to contextualize barriers to growth in the wider environment. We conceptualize barriers to growth on the firm level and the conditions for barriers on the entrepreneurial ecosystem level. Our theoretical development is based on 32 interviews with company founders, investors, and representatives of support institutions, a 3-month observation of a batch of startups in a European venture accelerator, and the previous scientific literature. Specifically,

we used grounded theory principles (Glaser & Strauss, 1967; Suddaby, 2006) and the concept development process outlined by Podsakoff, MacKenzie, and Podsakoff (2016). Our study thus answers calls for more qualitative approaches to the study of barriers to growth (Doern, 2009; Lee, 2014). We set specific boundaries for our theory. Our investigation is limited to privately-owned, high-tech companies in the ICT industry, a dynamic context characterized by high turbulence and fast-paced growth. We are only interested in the initial stages of organizational development: the start-up and growth phase of small- and medium-sized companies (SMEs), particularly startups. Our theory does not apply to old, mature, and large diversified companies.

We propose to make two contributions to the literature. The main contribution is a thorough conceptualization of the barriers to growth concept. We see barriers to growth as firm-level factors that limit the growth of firms. The configuration of five barriers (finance, human capital, growth ambitions, growth management knowledge, and product-market fit) is unique to every firm at any specific point in time. The principal novelty is our conceptualization of barriers as necessary conditions for growth. We thus make a clear distinction between the barriers (necessary conditions) and the drivers of growth (sufficient conditions). The necessary conditions logic demands that all necessary conditions must be fulfilled if the firm wants to grow, but they are not enough. The implications are both practical and methodological. Entrepreneurs and policymakers must view the problem holistically when trying to eliminate barriers. Eliminating just one barrier (e.g., finance) is insufficient, and all of them must be eliminated if the firm is to grow. Traditional regression-based methods are inappropriate for studying the barriers because they are based on the additivity of effects and sufficiency logic. Second, we extend Spigel's (2015) conceptualization of the entrepreneurial ecosystem with its influences on barriers to growth on the firm level. This means we not only conceptualize the barriers, but also specify the causal connections between ecosystem-level factors (i.e. conditions for barriers) and firm-level barriers.

3.2 Theoretical background

In this section, we briefly review the literatures on barriers to growth and entrepreneurial ecosystems. Barriers to growth is a long-standing research stream that investigates internal and external factors that limit the growth of firms. Entrepreneurial ecosystem, in contrast, is a nascent concept that has only recently gained significant attention in academic literature. It addresses the contextual nature of high-growth entrepreneurship (Mason & Brown, 2014). Both concepts have been criticized for being undertheorized (Doern, 2009; Spigel, 2015). We see an opportunity for our contribution to bridge the gap between these two literatures, and thereby add to their theoretical development.

3.2.1 Barriers to growth

Barriers to growth are usually viewed as internal or external factors that constrain the growth potential in firms that wish to grow (Storey, 1994:154). The extent to which particular barriers are internal to the firm (e.g. insufficient resources) or external (e.g. a lack of skilled labor) is one of the central issues in the barriers to growth literature. Internal barriers are under the influence of firms' entrepreneurs and managers, while external barriers are the domain of policymakers and other ecosystem actors. Aside from the internal/external division, there is no standard categorization of the different barrier types. Here are two examples. Barriers can be classified as institutional barriers, internal organizational and resource barriers, external market barriers, financial barriers, and social barriers (Bartlett & Bukvič, 2001). Alternatively, they can be categorized as formal, informal, environmental, and skills barriers (Aidis, 2005). A summary of previous studies – their focus, sample characteristics, barrier categorization and main findings – is presented in Table 9.

Table 9. Summary of selected barriers to growth studies.

Article	Focus	Data & sample	Barrier types (classification)	Main findings
(Aidis, 2005)	Barriers to SME operations in Lithuania	332 SMEs	formal, informal, environmental, and skills	Perceived formal barriers are associated with perceived informal barriers such as corruption and perceived environmental barriers are associated with perceived skill barriers such as management problems.
(Bartlett & Bukvič, 2001)	Key barriers to small business growth and development in Slovenia	173 SMEs in all sectors except agriculture	institutional, internal organizational and resource, external market, financial, and social	The key barriers are factors linked to the institutional environment including bureaucracy, and to external financial constraints including the high cost of capital.
(Hoxha & Capelleras, 2010)	Determinants of fast growth in Kosovo	585 interviews with firm founders	formal, informal, skills	Only barriers related to informal factors have shown a significant negative effect on growth. Declining firms suffer the most due to informal barriers.
(Pissarides et al., 2003)	The main objectives and constraints influencing the behavior of SMEs in Russia and Bulgaria	Survey of 437 managers (CEOs) of SMEs in Russia (216) and Bulgaria (221)	ten areas: production, expanding production, obtaining technology, procurement of non-labor inputs, sales, obtaining financing, securing infrastructure, regulation and taxation, labor, and business services	The most serious are constraints on obtaining external financing and the high cost of loans.
(Doern, 2011)	How perceived barriers influence the growth intentions and behaviors of owner-managers in Russia	Interviews with 27 owner-managers in St. Petersburg	-	Six ways barriers influence growth intentions: stop owner-managers from intending to grow, undermine intentions, add to the ambivalence around growth intentions, provide incentives to grow, postpone intention realization, and slow down the process of realizing intentions to grow

(Alex Coad & Tamvada, 2012)	Barriers to growth among small firms in India	Census data on a large sample of 600,000 small businesses	-	The main problems for large firms are labor and market problems. Small firms are more vulnerable to a lack of demand, problems obtaining working capital. Old firms suffer from labor and market problems, but also from a lack of demand and problems with raw materials. The main problems faced by female firms concern raw materials and market problems. Rural firms are less exposed to problems with labor and market demand. Exporting firms cite labor problems as the most significant barrier.
(Doern & Goss, 2013)	New conceptualization of barriers not as objective obstacles but as a process of barring	Qualitative interviews with 25 entrepreneurs in Russia	-	Barriers to entrepreneurial action are dynamic socio-emotional processes and not objective or subjective obstacles. The process of barring might reduce the entrepreneurs' motivation to pursue growth.
(Das & Das, 2014)	How business constraints limit the performance of micro (up to 10 employees) and small (up to 49 employees) manufacturing firms in India	Two waves of a World Bank survey. 1,300 firms participated in 2002, 608 firms in 2006.	policies, legal/ethical environment, access to capital, taxation, infrastructure	Regulatory quality (policies) and control of corruption (legal/ethical environment) improved slightly between 2002 and 2006. Improvement in the availability and cost of capital was experienced by small firms, but not by micro firms. In general, business constraints were slightly relaxed between 2002 and 2006, but the performance of firms was worse in 2006.
(Kozan, Öksoy, & Özsoy, 2006)	Assess growth intentions and environmental constraints in Turkey	526 SMEs in 14 major cities	-	Lack of know-how and financial constraints are significantly connected to growth plans. Continuous financing is a major problem when it comes to market expansion and technological improvement.

(Robson & Obeng, 2008)	Barriers to growth in Ghana	500 entrepreneurs from six regions	finance, market, managerial/technical know-how, inputs, economic/regulatory, infrastructure, socio-cultural	The three greatest problems reported were high inflation, high interest rates, and the high depreciation rate by Cedi. Businesses employing family members were more likely to encounter problems than others. Corruption and registration, licensing and red tape were among the least mentioned barriers.
(Gill & Biger, 2012)	Barriers to small business growth in Canada	219 small businesses (<150 employees)	financing, management skills, market challenges, regulatory issues	Lack of financing, market barriers, and regulatory issues are perceived as the main obstacles to growth. Past success (past sales level) has a significant effect on subsequent growth.
(Lee, 2014)	To investigate the obstacles perceived by firms in periods of high growth and potential high-growth firms in the UK.	4,858 SMEs from an Annual Small Business Survey	market factors, recruitment, government, finance, management, premises	High-growth firms perceive problems in six areas: recruitment, skill shortages, obtaining finance, cash flow, management skills, and finding suitable premises. Potential high-growth firms feel held back by the economy, obtaining finance, cash flow and their management skills, but are less likely to perceive regulation as a problem.
(Lee & Cowling, 2013)	Do firms in deprived areas perceive different barriers to success than other firms?	7,670 UK-based small firms	-	On the national level for both deprived and non-deprived areas, the most important perceived barriers to success are: regulations, the economy, tax, cash flow, access to finance, recruitment. Only two factors were strongly associated with deprived areas (i.e. the variables are stronger in deprived vs. non-deprived): "economy" and "access to finance".
(Keogh & Evans, 1998)	Identify the problems firms have in formulating strategies.	In-depth interviews with 20 owners, directors, and senior managers of NTBFs in	Internal, external, systematic	The following barriers to growth were identified: having the right people, having access to finance. Limitations to growth are determined by the market conditions within the identified niches.

Aberdeen, Scotland				
(Parry, 2010)	Understand the mechanisms by which such barriers arise.	Semi-structured interviews with owner-managers of 20 micro-level artisan businesses	-	An artisan identity can be a barrier to business growth. The holistic, hands-on approach is reflected in the artisan management style and limits growth in terms of the span of control and volume of activity.
(Galati, Bigliardi, Petroni, & Marolla, 2016)	Investigate the reasons inhibiting the growth of established academic spin-offs in Italy.	15 spin-offs	spin-off-related, entrepreneurial team-related, university-related, government-related	The growth of academic spin-offs is influenced by both external factors that cannot be influenced by the spin-off (e.g., level of regulation, bureaucracy required by government) and by spin-off-related variables (e.g. level of investment in capital resources, the human resources employed).

Arguably, the most researched barrier is financial constraints on growth. Obtaining capital is one of the biggest obstacles to starting and growing a business. Particularly smaller and younger firms are more vulnerable to financial constraints (Oliveira & Fortunato, 2006). New high-tech companies face a significant difference between the cost of internal and external funds, forcing most to finance new investments internally (Revest & Sapio, 2012). The extensive literature in economics researches the role of information asymmetries in preventing SMEs from obtaining funds necessary for growth (Alex Coad, 2010). The main assumption of this stream of research is that firms want to grow but are denied access to finance by market failure caused by asymmetric information between the users and providers of financing. The inability of SMEs to obtain finance is interpreted as a market failure and a cause for government intervention.

Institutional barriers like taxation and regulation are also often regarded as an important impediment to growth. Andersson (2003) found that rules and taxation make it hard to attract foreign talent to Sweden. Budak and Rajh (2014) examined how the business sector deals with corruption in seven Western Balkan countries. They found that some entrepreneurs understand corruption as 'greasing the wheels' and that a key component of fighting corruption would be to raise anti-corruption awareness. Interestingly, some studies reported (Xheneti & Bartlett, 2012) that firms which were more aware of corruption grew faster. Aidis (2005) conducted a study on 332 Lithuanian SMEs and found that formal and informal barriers are interrelated.

A large amount of the barriers to growth research is geographically focused on Central and Eastern European transitional countries. Barriers to growth have been researched in Lithuania (Aidis, 2005), Albania (Hashi, 2001; Xheneti & Bartlett, 2012), Kosovo (Hoxha & Capelleras, 2010), Slovenia (Bartlett & Bukvič, 2001), Russia (Doern, 2009), and Bulgaria (Pissarides et al., 2003). Another focus has been on developing countries like India and Ghana (Alex Coad & Tamvada, 2012; Das & Das, 2014; Robson & Obeng, 2008) or specific contexts in developed countries like the UK and Canada (Gill & Biger, 2012; Lee & Cowling, 2013).

Very little effort has been spent researching barriers to growth in high-tech firms. Lasch, Roy, and Yami (2007) found that finance- and customer-related variables were the critical success factors of ICT startups. On the other hand, human capital and working experience had no significant impact on growth. Keogh and Evans (1998) identified having the right people and having access to finance as the two most important barriers to the growth of new technology-based SMEs. Moreover, growth intentions were found to be associated with technology-based startups becoming medium-sized (Saemundsson & Dahlstrand, 2005). A recent study examined Italian academic spin-offs and found 19 barriers to growth in four categories: spin-off-related, entrepreneurial-team-related, university-related, and

government-related (Galati et al., 2016). It seems that certain contexts (e.g., Central and Eastern European transitional countries) are well researched, but others (e.g., developed countries and specifically high-tech firms) are in need of substantially more research.

The barriers to growth literature has been criticized for numerous shortcomings. The most thorough and comprehensive critique was made by Doern (2009). First, research on barriers to growth often does not distinguish actual and perceived barriers to growth. The problems perceived by entrepreneurs are not automatically barriers. Most research on barriers is based on the assumption there is a strong connection between perceived and actual barriers. Second, there are several theoretical and conceptual issues. The same concept is labelled differently in different studies (e.g., barriers, obstacles, constraints) with little effort to define the terms and distinguish similar concepts. The concept of barriers is underdeveloped and undertheorized (Doern, 2009). Even though barriers refer to internal and external factors that constrain growth, no specific definition has been broadly recognized.

Third, there are significant methodological problems in the existing literature. It seems that no standardized and pre-tested measures of barriers are used. Most studies employ a cross-sectional design which cannot distinguish between the cause (barrier) and the effect (low growth). They are often subject to retrospective bias as they require participants to retroactively identify the important barriers. A positive selection bias is another possible problem as studies often do not account for failing firms. Fourth, most studies are concerned with constraints on the growth of the general population of SMEs without concentrating on a particular industry. The barriers in particular contexts might vary greatly. Finally, the literature does not seem to converge on a stable set of findings. For example, corruption has often been mentioned as an important barrier to growth, but some studies suggest that companies that complained about corruption actually performed better (Xheneti & Bartlett, 2012). It is very difficult to make sense of the results, even after a thorough reading of the literature.

3.2.2 Entrepreneurial ecosystems

Entrepreneurship literature has been criticized for being too focused on the individual and not enough on the contextual factors that have a regulating effect on an individual action (Ács, Autio, & Szerb, 2014). Entrepreneurial ecosystems are rapidly becoming an important framework for discussing relational and contextual aspects of high-growth entrepreneurship. Stam (2015, p. 1765) developed a simple definition: “The entrepreneurial ecosystem is a set of interdependent actors and factors coordinated in such a way that they enable productive entrepreneurship”. The concept offers a new perspective on firm growth that emphasizes the role of the external environment (Mason & Brown, 2014). Developed entrepreneurial ecosystems can help entrepreneurs grow their companies by drawing on a supportive culture, mentorships, investment capital and other resources.

Entrepreneurial ecosystems research stands on the shoulders of its main intellectual predecessors: clusters and innovation systems. The crux of this literature is that context matters. The behavior, strategies, and performance of firms depend on the contextual factors. Cluster theory stems from the early work of Marshall (1920) who was one of the first to argue that firms located near each other can benefit from shared infrastructure, a specialized supplier base and available skilled labor. Marshall's ideas reappeared in the modern age in the work of Porter (1998), who further developed them to help regional governments design strategies to boost the competitiveness of their economies. Innovation systems (Lundvall, 1992; Nelson, 1993), on the other hand, focused on the role of systemic institutions in driving knowledge production and innovative performance. The entrepreneurial ecosystem literature builds heavily on these two concepts. The main difference is that entrepreneurial ecosystems put the entrepreneur and entrepreneurial community leadership at the center. Clusters concentrating on agglomeration, knowledge spillovers, and innovation systems emphasized the role of institutions. However, both perspectives neglected the role of individual action.

Even though the entrepreneurial ecosystem concept has gained enormous popularity among entrepreneurs and policymakers, the evidence base for it is currently quite small. Researchers have started working on its conceptual development, but empirical research is still rare. In addition to the lack of empirical research, there are some conceptual problems. At first, the concept appears to be tautological (i.e. good entrepreneurial ecosystems produce successful entrepreneurship and the presence of successful entrepreneurship is a sign of a well-developed entrepreneurial ecosystem) (Stam, 2015). The approach currently just offers long lists of factors without clear connections between the cause and the effect. It seems insufficiently theorized (Spigel, 2015).

We embed our conceptualization of barriers to growth in Spigel's entrepreneurial ecosystem definition. In one of the first formalizations of entrepreneurial ecosystems in the scientific literature, Spigel (2015) conceptualized entrepreneurial ecosystem as a set of ten interrelated attributes. These can be grouped into three types: cultural, social, and material. Cultural attributes are the underlying beliefs and attitudes to entrepreneurship. The culture defines what are the appropriate and acceptable practices and norms (Aoyama, 2009). There are two cultural attributes: cultural attitudes and histories of entrepreneurship. Cultural attitudes, for example, determine whether starting a new venture is a valid career path, and the societal status of entrepreneurs. Histories of entrepreneurial success provide role models for younger entrepreneurs and legitimize the status of risk-taking (Spigel, 2015).

Social attributes are "the resources composed or acquired through the social networks" in the system (Spigel, 2015). There are four main social attributes of an entrepreneurial ecosystem: networks, investment capital, mentors and dealmakers, and worker talent. Social networks act as a transmission mechanism for learning about new opportunities and

technologies. They help to obtain access to financing. Social connections assist entrepreneurs in acquiring resources on favorable terms. Investment capital (venture capital, angel investors, entrepreneur's family and friends) determines the opportunities for growth financing. Investors can also act as advisers to help entrepreneurs navigate the growth process. Mentors have a favorable influence on an entrepreneur's success (Ozgen & Baron, 2007), while dealmakers proactively build new connections among actors in the ecosystem, and thus help increase new venture formation and growth (Feldman & Zoller, 2012). Finally, young growing firms need worker talent with sufficient human capital and familiarity with small firms' demands.

The third category of entrepreneurial ecosystem attributes is material attributes: universities, support services and facilities, policy and governance, and open markets. Universities develop new technologies through scientific research and human capital by educating their students. Support services and facilities provide targeted assistance to startups: accountants, shared administrative services, patent lawyers, and other support services. Policies and governance influence venture growth through laws and regulations and are part of the political and economic context in which firms operate. The last attribute – open markets – provides opportunities for developing and testing new products in cooperation with local customers. The attributes of an entrepreneurial ecosystem are interdependent and mutually reinforcing.

One very important idea behind Spigel's definition is not captured by simply listing the entrepreneurial ecosystem attributes: namely, the interdependence of these attributes. They reinforce each other. Cultural attributes are the foundation for the social network that emerges in the region. Material attributes like policy and governance struggle to make an impact without an existing community of entrepreneurs and investors. The more dense the connections among the different attributes, the more synergies are possible. In sparser contexts, the ecosystem's development of other attributes is usually driven by one or two attributes (Spigel, 2015).

3.3 Data and Methods

3.3.1 Methodological approach

Doern (2009) described the theoretical underpinnings and methodological practices of the barriers to growth research as unsatisfactory. Our own literature review revealed that authors do not rigorously define what they mean by 'barriers'. The first version of Table 9 for this chapter (summary of barriers to growth research) initially had a column named 'barriers to growth definition'. The column was eventually deleted because the existing studies contained little to include there.

Bad concept definitions are hindering the progress of research. The lack of conceptual clarity means it is difficult to distinguish a concept from other concepts, thus undermining discriminant validity (Podsakoff et al., 2016). If the meaning of a concept is not properly defined, it is also difficult to define its nomological network, its antecedents, and consequences. Further down the road, a bad definition may lead to deficient operationalization of a concept, increasing the possibility of a mismatch between the concept and its measures. Rigorous concept development is often neglected, but having a good concept definition is vital before the process of developing a measure can begin.

A good concept definition must define the key characteristics of a phenomenon of interest (Podsakoff et al., 2016). It needs to specify how generalizable the concept is across different contexts. Another important consideration is the concept's stability over time. Some concepts (e.g. personality traits) change relatively little within person over time, but have great variability across different people. Further, the definition must be able to differentiate between the focal concept and related concepts. Tautological statements (i.e. a restatement in different words of the phenomenon to be defined) should be avoided. Finally, the concept should not be defined just with its antecedents and consequences, but must also contain a positive statement about the essence of the concept (Podsakoff et al., 2016). Our aim is to develop a definition of barriers to growth according to these principles.

We used the four-step process of creating a concept definition recommended by Podsakoff and colleagues (2016): (1) identify the potential attributes of the concept and collect a representative set of definitions; (2) organize the potential attributes by theme and identify any necessary and sufficient ones; (3) develop a preliminary definition; and (4) refine the conceptual definition.

The first step involves identifying the potential attributes of the concept. This can be done with a combination of different methods: searching the dictionary, surveying the literature, interviewing experts and/or practitioners, conducting direct observation, producing case studies, and several other methods. Depending on how many and how good any previous definitions are, different methods might be more important. A purely inductive approach is the most appropriate when no or very little previous research exists on the topic (Graebner, Martin, & Roundy, 2012). On the other hand, if several conceptual definitions already exist, a thorough survey of the literature might be the most important activity (Podsakoff et al., 2016). In our case, we have a mixed situation: barriers to growth have been extensively studied before, but few authors bothered to properly define them. Therefore, we put equal weight on both inductive (interviews, direct observation) and deductive approaches (literature review).

To balance the inductive and deductive theory building, we drew on the recommendations for inductive top-down theorizing provided by Shepherd and Sutcliffe (2011). This approach envisions a set of strategies (abduction, constant comparison of sensory and conceptual representations, thought experiments and others) to arrive at good conceptual representations. It is most appropriate “when the body of previous research is vast, dynamic, complex and/or from disparate sources” (Shepherd & Sutcliffe, 2011, p. 374). Reviewers in top management journals often view qualitative inquiry as an inductive process (Gioia, Corley, & Hamilton, 2013; Pratt, 2009), but the calls for greater use of a mix of inductive and deductive theorizing are not new (D. A. Shepherd & Sutcliffe, 2011). Eisenhardt (1989) acknowledged that the goal of the purely inductive bottom-up approach is impossible to achieve; therefore, in reality scholars commonly employ a mix of two approaches (Graebner et al., 2012).

Our approach to gathering and analyzing qualitative data uses grounded theory principles (Glaser & Strauss, 1967). Two tenets form the core of grounded theory approach (Suddaby, 2006): constant comparison (data are collected and analyzed at the same time) and theoretical sampling (the collecting of data is determined by the process of constructing theory and not by statistical considerations). Another basic principle of grounded theory is that there are no rules regarding which data sources are appropriate for research (O’Reilly et al., 2012). The approach can thus incorporate different data sources, such as interviews, books and newspapers, archival documents, observations, and other data the researcher may collect.

After identifying the concept’s potential attributes, the second step in the development process organizes attributes by theme (Podsakoff et al., 2016). The researcher must also determine which attributes are necessary (which all cases of the concept must possess) and sufficient (which only cases of the concept possess). In the third step, a preliminary definition of the concept is developed. This is the time to check whether the definition of the concept has all the characteristics of a good concept definition as summarized before and outlined in detail in Podsakoff et al. (2016). The fourth and final step involves refining the conceptual definition. First attempts at defining concepts are seldom perfect. The researcher must thus ensure “that the final version of the conceptual definition is clear, concise, understandable to a broad audience, and not subject to multiple interpretations” (Podsakoff et al., 2016, p. 188).

3.3.2 Data collection

The main data collection method was semi-structured interviews. We conducted the interviews in two waves between November 2013 and December 2015. We primarily targeted the founders and CEOs of three different kinds of Slovenian ICT startups: (1) startups with own developed software or (mobile) application that provides a solution to a

problem for end users; (2) »Internet of things« startups that bundled hardware with an Internet/mobile provided service; and (3) companies that mainly provided software development services for other companies. We sampled different types of companies: soon after founding, companies struggling to achieve growth, companies at the start of their growth trajectory, and companies with significant growth behind them. All companies but one were small- or medium-sized; the exception was the interview with the CEO of the subsidiary of a multinational corporation. Two interviewees were serial entrepreneurs whose latest ventures were based in Silicon Valley and London. They are thus able to compare their experiences between the Slovenian and these ecosystems. Besides founders, we targeted other knowledgeable informants about the process of high-tech companies: support-institution staff who deal with entrepreneurs on a daily basis, consultants, and investors. We chose the ICT context because: (1) it is under-researched in the barriers to growth literature; (2) there have been calls for more context-focused examinations of growth (Davidsson et al., 2010); and (3) because high-tech companies, especially in the ICT sector, are capable of extremely fast growth (e.g. WhatsApp, Uber, Snapchat).

Altogether, we conducted 32 in-depth interviews with company founders, industry analysts, support-institution representatives (e.g. venture accelerator staff), investors, and consultants. Twenty-five interviews were conducted face-to-face and seven via Skype. The interviews lasted between 23 and 75 minutes with an average length of 42 minutes. All but three interviews were recorded and transcribed verbatim, resulting in 331 pages of interview transcripts. Three interviews were not recorded because we deemed it not appropriate by the setting or due to the participant's request. On two of these occasions, we kept detailed notes during the interview, while in the other case the notes were produced immediately after the conversation. Thirty subjects were male and two were female. Seven interviewees were at the time of interview in the 20–29 age bracket, sixteen in the 30–39 bracket and nine were aged 40 or older. The list of informants is summarized in Table 10.

Table 10. List of informants.

No.	Role	Firm age [years]	Gender	Method	Length (min.)
1.	consultant	n.a.	Male	Face-to-face	58
2.	support institution representative	n.a.	Male	Face-to-face	75
3.	founder & CEO	1	Male	Face-to-face	35
4.	analyst	n.a.	Male	Face-to-face	65
5.	founder & CEO	3	Male	Skype	27
6.	investor	n.a.	Male	Skype	50
7.	founder & CEO	1	Male	Face-to-face	38
8.	founder	7	Male	Face-to-face	32
9.	founder & CEO	2	Male	Skype	23
10.	founder & CEO	4	Male	Face-to-face	34
11.	founder & CEO	2	Male	Face-to-face	41
12.	founder	1	Male	Face-to-face	36
13.	investor	n.a.	Male	Face-to-face	54
14.	support institution representative	n.a.	Female	Face-to-face	34
15.	founder & CEO	1	Male	Skype	30
16.	founder & CEO	6	Male	Face-to-face	29
17.	support institution representative	n.a.	Female	Face-to-face	41
18.	founder & CEO	9	Male	Face-to-face	38
19.	founder & CEO	1	Male	Skype	48
20.	CEO	2	Male	Skype	35
21.	founder & CEO	1	Male	Face-to-face	43
22.	support institution representative	n.a.	Male	Face-to-face	43
23.	support institution representative	n.a.	Male	Face-to-face	53
24.	founder & CEO	11	Male	Face-to-face	55
25.	support institution representative	n.a.	Male	Face-to-face	44
26.	founder & CEO, angel investor	26	Male	Face-to-face	43
27.	CEO	22	Male	Face-to-face	26
28.	founder & CEO, angel investor	24	Male	Face-to-face	50
29.	support institution representative	n.a.	Male	Skype	35
30.	founder & CEO	3	Male	Face-to-face	23
31.	founder & CEO	2	Male	Face-to-face	44
32.	founder & CEO	1	Male	Face-to-face	54

We started our inquiry by being generally interested in the growth process of high-tech companies. The initial interview guide consisted of open-ended questions with the aim of discussing technology entrepreneurs' experiences when trying to expand their companies. Our informants often talked about the problems of growth so we decided to focus on this subset of questions. A subsequent additional literature review uncovered the research stream on barriers to growth with all its findings and criticisms. One of the main criticisms was that the definitions of barriers are vague and unclear (Doern, 2009). This prompted us to try to refine the concept.

In the second set of interviews, we specifically concentrated barriers to growth. We updated the interview protocol to reflect this change. The final interview protocol is outlined in Appendix C. We simultaneously proceeded with gathering the interview data and making detailed notes of the existing literature. This interplay between inductive and deductive logic formed the basis of our development of a new definition of the barriers to growth concept.

We further refined our understanding of the growth process with the observation data. One of the authors spent three months in a venture accelerator program, following one generation of high-tech startups. Venture accelerators are support institutions that aim to ignite and sustain growth in (usually high-tech) startups by providing mentorship, networking opportunities, and access to funding (Pauwels, Clarysse, Wright, & Van Hove, 2016). Startups enter in batches and are provided with a modest amount of capital and working space. They spend three to six months in the program. The program ends with 'demo day' when entrepreneurs pitch to investors. After the success of the original accelerator – Y Combinator – this model has proliferated all over the globe (Cohen, 2013).

A batch of startups in an accelerator provides a perfect opportunity for direct observation. The observer followed one batch of startups from the start of the accelerator program to the demo day. The presence was maintained 2–3 times a week over three months. In particular, the observer was present at weekly business development meetings where startup founders and staff met with a board of advisers and presented their progress of the past week. The rest of the observation involved being around the co-working space of the accelerator, watching startups at work, and engaging in informal conversations with entrepreneurs in chance encounters.

3.3.3 Data analysis and concept development

We used the MAXQDA software for coding and analysis. We coded the gathered data in three phases according to the procedures outlined in Corbin & Strauss (2007). First, we assigned open codes to the interview and archival data. The purpose of open coding is to explore the data and summarize it with codes assigned to fragments of text. The codes are inductively synthesized from the data. In this phase, we closely examined the texts to find

relevant themes. In the second phase of the analysis, we performed axial coding to further elaborate on the initial open coding and delineate categories found in the data. The level of conceptual abstraction increased; we refined the relations among categories and subcategories by joining, disjoining, and relabeling open codes assigned in the first phase. A hierarchy of codes was formed. Finally, we used selective coding to determine the importance of the categories and embed inductive findings in the theoretical concepts.

We triangulated our findings by leaning on different data sources to build our model. Our incorporation of the grounded theory approach is particularly useful for this purpose because it can accommodate different data sources and data types – in our case, interview transcripts, observation data, scientific literature, and practitioner writings. Since the relationship between perceived and actual barriers was labeled a concern by previous research, we took extra care not to take the informants' claims on face value. We compared the responses with our observations and findings of past studies. We built our conclusions on this interplay and thus addressed possible informant bias (Graebner et al., 2012).

By this point, we had arrived at the first conceptual definition of barriers to growth and its five attributes. Four barrier concept attributes (finance, human capital, growth management knowledge, and product-market fit) were derived through a combination of inductive and deductive techniques. The fifth (growth ambition) was derived purely deductively from previous studies since our sample primarily consisted of entrepreneurs with high growth ambitions and a lack of growth ambitions was not their chief concern. Even though several support-institution representatives brought up the issue of growth ambition, this did not occur frequently enough to reach theoretical saturation of this category. Still, the inclusion of growth ambitions in our model is justified by the earlier research (e.g. Delmar & Wiklund, 2008).

In the final step, we proceeded with refining the concept. As recommended by Podsakoff et al. (2016), we first attempted to refine the definition ourselves, to make it as clear, concise, and understandable as possible. Then we discussed the definition with colleagues and practitioners, including the three interviewees.

3.3.4 Necessary conditions analysis (NCA)

The necessary conditions analysis (NCA) framework (Dul, 2016) provided the last piece of the puzzle required to complete our reconceptualization of barriers to growth. Necessary conditions are determinants that allow a certain outcome to exist, but are not sufficient to attain that outcome. Without the necessary condition, the outcome will not exist. Failure is guaranteed and cannot be compensated with by other determinants of the outcome. Take, for example, a passenger airplane. Having a powerful engine is a necessary condition for the plane to take-off, fly the passengers to its destination, and land. But having an engine is not

enough. The airplane must also have wings and other features to operate and fly. Having larger wings cannot substitute the absence of an engine. Therefore, a necessary cause is a bottleneck that must be managed to allow a desired outcome (Dul, 2016). Removing a bottleneck is absolutely necessary to improve performance; it will not improve just by increasing the value of other determinants.

In contrast, the sufficient causes produce the outcome. Traditional approaches are based on sufficiency logic. They often also use the additive rule where the effects of each cause add up to the outcome, meaning that the lack of one sufficient cause can be compensated by others. For example, the additive model is common in regression-based approaches and can be expressed as $Y = a + b_1X_1 + b_2X_2 + b_3X_3$ where b_i are regression coefficients and X_i the value of determinants. Necessary conditions can be better expressed as multiplication $Y = X_1 \cdot X_2 \cdot X_3$. If one of the determinants is zero, the outcome is also zero. NCA is a complement to the traditional approaches. It is more suitable for a subset of problems that are susceptible to necessary conditions logic, but cannot substitute the traditional approaches. Qualitative Comparative Analysis (QCA) (Fiss, 2007; Schneider & Wagemann, 2012) is another method that uses the necessary-sufficient conditions logic for making causal statements. QCA also does not use the additive rule and focuses on combinations of causes that are sufficient but not automatically necessary (Dul, 2016).

Hypotheses containing statements about necessary conditions should be tested with NCA, not traditional regression-based analyses. There is an elaborate analysis and testing procedure behind NCA that can be implemented using the NCA package in the R statistical software (Dul, 2015). NCA is not limited to the simple presence or absence of the necessary condition (values 1 and 0, respectively). It can also handle variables with discrete (e.g. Likert-scale survey responses) or continuous values (e.g., revenue in EUR). However, like every method, NCA has its limitations. First, it cannot solve the problem that causal connections are very difficult to depict by using observational data. Second, NCA is a conceptual causal framework and an analysis technique, not a data collection and measurement technique. Data for analysis still need to be collected using the established data collection techniques. Third, compared with traditional approaches it may be more prone to sampling and measurement error. Currently, analysis with NCA cannot take sampling error into account. NCA as a method of analysis is still in development. We use NCA just for theorizing, but the method could be applied to further empirically assess barriers to growth. We outline future research possibilities in this regard in the discussion section.

3.4 Barriers to growth in entrepreneurial ecosystems

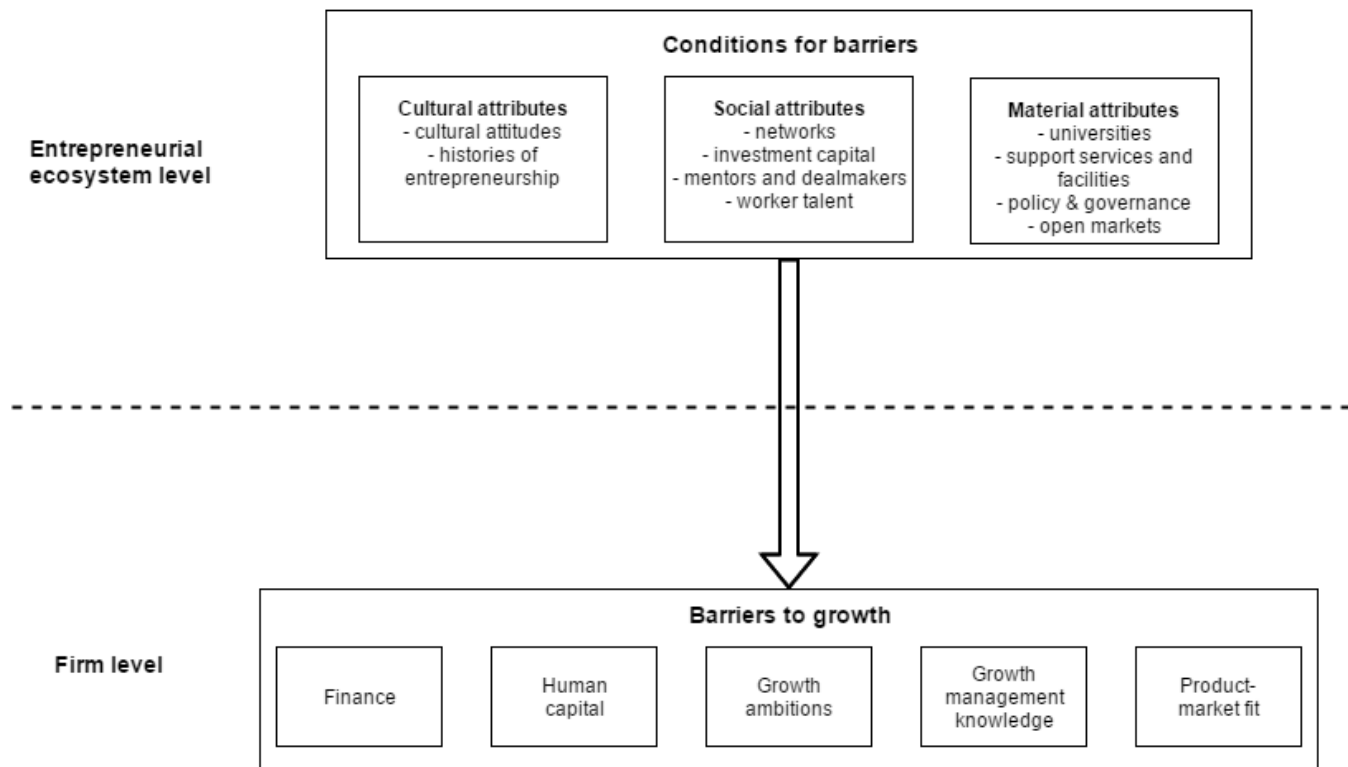
Barriers to growth are firm-level factors that are necessary conditions for persistent high growth. Each firm has its own unique configuration of barriers. They reflect a firm's specific

circumstances at a particular point in time. Barriers do not exist in a vacuum. They are influenced by entrepreneurial ecosystem-level factors. Conditions for barriers to growth are attributes of the entrepreneurial ecosystem that influence the actual barriers for firms in that entrepreneurial ecosystem.

Five attributes form the configuration of barriers to growth on the firm level: finance, human capital, growth ambition, growth management knowledge, and product-market fit. First, the firm must possess sufficient financial resources to finance its growth. Second, it must possess human capital in both the entrepreneurial team and employees and be able to attract new talent. Third, its owners and managers must have a growth ambition, or at least be willing to grow the company if the process takes off. Fourth, there must be enough knowledge in the company about building high-growth firms in order to successfully navigate the growth process. Finally, the company's offerings of products or services must be compatible with market demand; in other words, the company has achieved a product-market fit. We primarily aim to explain the growth of small- and medium-sized companies with a limited portfolio of products.

All five attributes are necessary conditions for sustainable growth. The configuration of attributes is idiosyncratic to every firm. The company must fulfill all five conditions for persistent growth to become a possibility. However, in accordance with the necessary conditions framework, this might not be enough to actually grow. The five attributes of barriers are inter-related, but not substitutable. For instance, a well-capitalized company might find it easier to attract talented people, but financing itself cannot compensate for having an inappropriate work force and leadership. Our conceptualization of the conditions for barriers (entrepreneurial ecosystem level) and barriers to growth (firm level) is visualized in Figure 17.

Figure 17. Barriers to growth in entrepreneurial ecosystems.



Our focus is on explaining persistent high growth over a longer period of time. We define persistent high growth as annual growth of 20 or more percent for a period of 4 or more years. There are two main ways to achieve temporary growth: finance push and market pull. For example, a company might develop a product with great demand on the market, in other words, achieve a product-market fit. This may trigger the company to start growing (market pull). However, without eliminating the other barriers, this growth will be one-off. For persistent growth, the company needs to acquire sources of finance (this can be from outside sources like venture capital or from its free cash flows), develop or hire appropriate talent, and its leadership must hold the ambition for further growth and be able to successfully navigate the growth process. Eliminating a powerful barrier like finance or achieving a product-market fit can put the company on a temporary growth trajectory. This buys time so the leadership can eliminate other barriers. But if other barriers are not dealt with, the growth will be eventually brought to a halt.

Concept definitions have to be different from other similar concepts in the field. In other words, a new concept has to exhibit discriminant validity. Barriers to growth first have to be distinguished from drivers of growth. This is best done within the necessary-sufficiency conditions framework. Drivers of growth are then factors that are sufficient for growth and barriers to growth are those factors that are necessary, but alone do not cause growth. Their

absence prohibits firms from growing, but their presence will not necessarily cause growth. The second problem is there are many similar names for what could be barriers: constraints, obstacles.... Because these are also under-defined, we do not attempt to define and distinguish them all. One possibility is to treat them as synonyms for barriers. Another option is to try to define them as separate concepts, but this is beyond the scope of this chapter.

We provide some sample quotes supporting each of the barrier attributes in Table 11, before proceeding to describe each attribute in detail.

Table 11. Barriers and sample quotes from the interviews.

Barrier	Sample quotes
Finance	<p>“We built the product to prototype stage, but then we needed outside capital because of the high development costs. We didn’t get it in Slovenia, so we went on Kickstarter.” – i5</p> <p>“It is extremely difficult to get to real VCs. The real decision-makers, Peter Thiel-type guys, are very hard to get access to. This is the first thing I experienced.” – i24</p> <p>“Our problem is we have no money. We do all other things just to survive, our cash flow is catastrophic.” – i11</p> <p>“We don’t see banks being more mature. I’ll give you one example: our bank is not prepared to give us a credit card, unless we deposit cash with them and we need the credit card especially for travel.” – i20</p> <p>“These things can be expensive. We had an app 3 years ago which exploded; nobody expected an explosion like that. The first week we had 6,000, the second week 40,000 and the third week 200,000 users. But then we had to shut it down because we got an invoice from Google for USD 12,000 per week. We had no structure, so it was over.” – i2</p> <p>“If you need 15 million euros in Slovenia, you can’t get it. Nobody has it. That’s why you have to go abroad. You can do it, but it’s difficult. You need to act differently: company, mentality, everything.” – i25</p>
Human capital	<p>“I see it with myself. I am very demanding, but I don’t know how to build a team. This is still a riddle for me, how to build team systematically, how to get employees, how to retain them, how to teach them all these systems so they can function in a team... This is still all like voodoo to me. So the team is one of these key things that still frightens me.” – i11</p> <p>“You do not need a big team, you just need a team of very smart people which you then only supplement... if you find some complicated problem that only your team can solve, you don’t need a big team and a lot of employees.” – i3</p>

“Because the worker talent in our country is limited, you don’t get these really top teams. Building a startup and assembling a really top team of developers, salesmen and so on is difficult in Slovenia. Especially because the top people here have jobs and good salaries, and they are not prepared to change jobs for half the pay and maybe a share in a company.” – i13

“There’s one obstacle that is always constraining you! The team! This determines everything from A to Z. The team determines if you will get to the growth phase, determines if you can get through the growth phase. Everything else is some exercise to somehow get to product-market fit and sell things. The team is by far the most complex thing.” – i31

“We had this guy, his girlfriend said that she wants to move to London and he raised his hand and immediately got a job in London. Our boys, they tell me some things but not everything, and they are constantly bombarded with offers from Facebook, Google. These firms are really attacking the quality developers in Slovenia and you can’t see this from the outside.” – i8

“Now I see in retrospective that it wasn’t the best idea to form a team that is not heterogeneous enough. Especially I see the lack of business knowledge, the lack of a key person that would take care of business.” – i11

“The specificity of our environment is that you have the Biotechnical Faculty here at Rožnik and the Faculty of Economics across the city in Bežigrad. I think that university campuses play a big role here... in Stanford, Harvard you have different profiles from different departments mingling together.” – i13

“It’s great if the team consists of people who have domain knowledge. This is key. We have a lot of app developers, but if you have no domain knowledge on the market where this app will be sold... this is something you cannot learn later. You must have that experience. This is a marathon.” – i13

“International sales people. You can get developers, but international sales talent is very problematic. I really need global warriors, especially experienced ones.” – i26

Growth ambition “I’m thinking where could I do something big, something tangible. Where all this hard work will lead to some result. Because if there’s no result, I don’t think it’s worth the effort.” – i11

“There are no role models in Slovenia, that’s a fact. Role models are mostly craft workshops, which are known in some niche. But none of them have grown into a really large multinational corporation. Individuals can be very successful, but they keep their firms at 100 people, they don’t want to grow to 10,000.” – i31

Growth management knowledge	<p>“The problem was that then we did not have people in Slovenia who knew what we needed to do to take the next step. If we had, it would have turned out better.” – i19 (speaking about his failed venture)</p> <p>“When founding the company they think they know everything. But when the company grows, teams often disintegrate when they encounter the first serious obstacles, when this sharpness comes into business.” – i27</p> <p>“I think we’re great in Slovenia in the phase where there are fewer than 10 people in the company. We’re good at this phase. There are a lot of people who have tried it, and there are a lot of activities in these early phases.” – i19</p> <p>“Capital is missing because we don’t know how to handle it, how to get from 1 million to 1 billion.” – i28</p> <p>“Well, Slovenia definitely has a lack of people who would know how to bring a company from a garage startup to a serious organization.” – i29</p> <p>“This is just a matter of whether you’re capable of trusting people or not. I saw a lot of entrepreneurs who grew to about 50 employees, but they couldn’t go further. Every last one of them did not trust anybody. I think that 50 is that magical number where the day has only 24 hours and they couldn’t do more. But if you want to build a system you have to be surrounded by people you trust.” – i24</p> <p>“You didn’t ask anything about culture. This is one of the most important things, how to preserve the organizational culture so that it does not become bureaucratized, that people stay on friendly terms, whatever your culture is. You need to spend a lot of time on this; it must be deliberate but still spontaneous at the same time... In Slovenia this is even more important because it is not the norm to fire people, so you have to really think who you will accept into your company.” – i8</p> <p>“Here in Silicon Valley there are many more people who have experience of how to grow to a million or hundred million users. In Slovenia there are not many, but they do exist now. In SV you can skip this learning phase if you get into contact with the right people.” – i19</p>
Product-market fit	<p>“The precondition for growth is a product-market fit in a fast-growing market. If you want to get to that, you have to understand the market better than others. If you want to understand it, you have to have work experience in that market.” – i29</p> <p>“I saw a bunch of companies who built web apps as engineers, because they saw how great and difficult it is to build it. But in the real world it had no business model, no basis.” – i24</p>

“I see growth in a way that in this phase we have to prepare the instruments, because we are pre-product and pre-revenue. When we’ll have a product on the market and we start generating revenue, then it is the time to start the growth engine, not before. If you start the growth engine too early, you can build expectations too high, which you can’t meet in time.” – i19

“The most important thing is to understand the market, and this is difficult if you are far away. You can do it from a distance in some markets, but usually you must be close to the market both physically and psychologically.” – i8

“The biggest problem for teams is the small Slovenian market. The market is so small, so limited, that even as a test polygon it’s not good enough... teams limit themselves, the product has too many features too soon.” – i25

3.4.1 Finance

By finance, we mean the ability of a firm to finance its growth. High-tech startups need growth capital for several reasons. The first is to finance the product development costs. Especially for companies that initially establish a user base and figure out the monetization mechanism later, the costs of development and maintaining the service for the growing user base can be very high. The Internet of things startups need finance for the production of hardware and working capital. Finance is also required for marketing expenses to acquire users. It can be obtained from different sources: from investors as equity capital, borrowed from a bank, or internally from free cash flows.

The main ecosystem-level factors that influence companies’ ability to obtain financial resources are cultural attitudes, networks, investment capital, and policy and governance. Cultural attitudes determine what amount of risk and debt is culturally appropriate for entrepreneurs to take. Social connections help entrepreneurs obtain access to the right people (investors, bankers) who are the decision-makers for dispensing finance. Abundant investment capital in the region makes it easier for all startups to find equity capital. Policy and governance initiatives (e.g. guarantees, subsidies) can help acquire finance for those new ventures that would otherwise be disadvantaged due to poor credit ratings and unavailable collateral.

3.4.2 Human capital

There are three dimensions of the human capital barrier: the human capital of the founder team, the human capital of the employees, and the firm’s ability to attract and retain worker talent. Serial entrepreneurs with a track record of success bring knowledge and credibility to the new business (Mason & Brown, 2013). They are able to attract external financial investment and customers. Founding a team with deep domain experience will make it easier

and faster to develop products and services the market wants. One mechanism through which human capital acts as a barrier to growth is absorptive capacity (Cohen & Levinthal, 1990). The lack of human capital in founders and employees prevents the firm from acquiring and interpreting the knowledge needed for growth. Finally, if the firm wants to grow, it must be able to attract and retain talented workers.

The main ecosystem-level factors that influence the human capital barrier are: cultural attitudes, histories of entrepreneurship, networks, worker talent, and universities. Cultural attitudes are the basis for whether talented experienced people are prepared to establish or work for small companies. Histories of entrepreneurship change these attitudes with positive role models. Expansive social networks help entrepreneurs identify suitable employees and appropriate co-founders. Abundant worker talent is necessary to support growing firms' increasing needs for workers, while universities are one of the main factors in creating human capital.

3.4.3 Growth ambition

Not all entrepreneurs want to grow their firms. A bigger size is perceived as more hassle. With growth, there is an increasing burden of satisfying various regulations. Having more employees also increases responsibility and requires regular cash flows. Entrepreneurs become more like managers with less time to do what they want (Parry, 2010). Many founders establish companies with motives other than profit and growth: addressing social problems or satisfying needs of disadvantaged communities (Zahra, Gedajlovic, Neubaum, & Shulman, 2009).

Growth ambition is the main mediator through which the barriers perceived by the entrepreneur limit growth and can thus become actual barriers (Doern, 2011). This means that entrepreneurs' ambition to grow their firms would be an important barrier to growth.

The main ecosystem-level factors that influence the growth ambition barrier are: cultural attitudes, histories of entrepreneurship, investment capital, mentors and dealmakers, and open markets. Again, cultural attitudes influence how risky the entrepreneur's actions will be and this will in turn influence the growth ambition. Examples of successful entrepreneurs in the region and knowledgeable mentors can help overcome the adversity to risk inherent in growth. Investment capital encourages entrepreneurs to have greater ambitions than they would normally have. Open markets can help fuel the growth ambition with abundant opportunities for expansion.

3.4.4 Growth management knowledge

Fast growth can exceed the managerial capacity, compromise the organizational culture or put strains on the company's finances. Entrepreneurial venture at a certain point needs more

order and a management process. This can exceed the capacity of the founders to successfully manage the venture and they then need to be replaced with professional management. When the company employs a significant proportion of its workforce every year, it is difficult to maintain the organizational culture and keep employees informed about the company's values and strategic priorities. Fast growth can deplete a company's finances and accelerate its need for more investment. Its leadership needs to know how to navigate this process.

The main ecosystem-level factors that influence the growth management knowledge barrier are: networks, investment capital, mentors and dealmakers, worker talent, and support services and facilities. Entrepreneurs embedded in expansive networks can more easily identify people with growth management knowledge if that is insufficiently present in the company. Investment capital investments often come with experience in handling the growth process. Mentors can also advise the founders when growth problems arise. If there is an abundance of people on the market who have first-hand knowledge of the growth process, ventures can hire the appropriate worker talent. Finally, support services and facilities can help growing companies.

3.4.5 Product-market fit

The main precondition for growth is a product-market fit. This means "being in a good market with a product that can satisfy that market" (Andreesen, 2007). A good market can act as a pull and ignite the growth trajectory of a startup if it delivers on an unsatisfied need. The main ecosystem-level factors that influence the product-market fit barrier are: networks, mentors and dealmakers, and open markets. Networks and the proximity of customers mean that entrepreneurs can identify customer needs more easily. Mentors who have gone through the process of finding a product-market fit can guide them with their experience and knowledge.

3.5 Discussion and conclusion

We have presented the main barriers that prevent startups from entering the growth stage and keep growing during the growth stage. We have investigated the barriers to growth in a high-tech context, which is under-researched in the barriers to growth literature.

Will removing the barriers to growth lead to a bonanza in high-growth companies? It is not so simple. We conceptualized five barriers (finance, human capital, growth ambition, growth management knowledge, and product-market fit) as necessary conditions for growth. Entrepreneurs have to eliminate all of them just to have the possibility of persistent growth. Working simultaneously on all barriers is extremely difficult for resource-limited companies like high-tech startups. What is more, eliminating the barriers is just a necessary, not a

sufficient condition. For growth to materialize, companies also depend on other factors like a competitive environment, their success in reaching customers and, yes, luck. However, we claim that, without solving the five barriers, high-tech companies will be unable to grow persistently.

With our conceptualization of the barriers we were able to provide solutions to several weak points of the barriers research (Doern, 2009). First, our conceptualization is thorough and holistic. It embeds the barriers in the entrepreneurial ecosystem concept. We developed the conceptualization according to the principles of concept development (Podsakoff et al., 2016). We are thus able to mitigate the stated problem that the barriers to growth concept is “undertheorized” (Doern, 2009). This definition of barriers to growth is the first step towards better operationalization of the concept. Our theorizing also takes into account the difference between actual and perceived barriers. The perceived barriers are not barriers per se, but antecedents that influence the growth ambitions of entrepreneurs (Doern & Goss, 2013).

We have conceptualized barriers as necessary, but not sufficient conditions for growth (Dul, 2016). One consequence of this distinction is methodological. Traditional regression-based methods with their rule of linear additivity may be appropriate for empirically examining drivers of growth, but inadequate for assessing barriers to growth. The principle reason is the requirements of the necessary conditions logic. These state that one of the necessary conditions cannot substitute others and that all conditions must be present for the outcome to occur. Barriers to growth thus have to be empirically examined with NCA or similar methods like QCA that do not violate the logic of necessary conditions.

3.5.1 Implications for practice and policy

Our framework provides a long-term lens for entrepreneurs that can help their thinking about the growth and development of their company. Seasoned entrepreneurs will be able to relate to the five barriers and can use the framework to frame their experience when advising younger colleagues. Some barriers can change fairly quickly, others very slowly. The financial position of a company can change overnight if a sizable investment capital is received. In contrast, decisions about the founding team are the most difficult to correct later. Entrepreneurs must aim to eliminate all barriers to growth if they wish to grow persistently. Temporary growth triggered by finance push or market pull provides them with time to systematically deal with the barriers.

Policy measures should apply a holistic strategy to lowering barriers to growth. Because every barrier is a necessary condition for growth, it is not enough to focus on just one barrier. For instance, policymakers have so far had too great a focus on finance, and should spend additional resources on eliminating other barriers. Policies can encourage and fund stronger links with existing ecosystems where knowledge of building high-growth firms is abundant

(e.g. Silicon Valley, Israel). Currently, less developed ecosystems are losing their best entrepreneurs that go on and establish companies in the more developed ecosystems. It should be ensured that the knowledge thereby gained flows back to original entrepreneurial ecosystems.

Universities can play a part in solving the overly homogenous nature of founding teams. They can implement interdisciplinary technology entrepreneurship programs to enable students from computer science, business, engineering, and design to meet each other and exchange ideas. The problem of the lack of sales knowledge may be solved by establishing ‘growth academies’ – funded by government institutions but run by entrepreneurs themselves to enable the exchange of knowledge between entrepreneurs and sales personnel.

3.5.2 Limitations

The first limitation stems from the methods. We used qualitative methods to develop a new conceptualization of barriers to growth. Qualitative methods are appropriate for developing a theory, but unable to test it. Our theory – although well substantiated – should be regarded as tentative for as long as quantitative research examinations are unable to refute it. Also, our concept of barriers was developed in a specific context of Slovenian high-tech companies. We could have missed some barriers that are important for other types of companies in other geographical contexts. Researchers should thus be careful before generalizing to other contexts.

Our model covers regional and firm levels, but does not specify how the conditions in the global and national economy influence the firm-level barriers. For example, access to credit was much easier in the time before the start of the global financial crisis in 2008, than after. The model also does not fully cover psychological individual-level barriers. These are to a certain extent embedded in the growth ambition dimension, but full coverage of these complex issues would need a more detailed specification of barriers on individual level. However, our data does not allow for this, therefore we must add this as a limitation of our model. In addition, our theory is only valid for SMEs. The situation of mature diversified companies is much more complicated and our model is unable to capture that complexity.

3.5.3 Suggestions for future research

Future research could proceed along four avenues: (1) qualitative research delving deeper into mechanisms whereby entrepreneurial ecosystem-level factors influence barriers to growth; (2) multilevel quantitative research that would use NCA or related methods to examine how much each barrier constrains growth; (3) to examine the extent to which this conceptualization of barriers is generalizable to other types of companies and other contexts; and (4) examining how wider societal issues influence growth barriers on firm level.

First, we specified some mechanisms of the causal connections between the conditions for barriers and the actual barriers, but future research needs to look much more deeply into these mechanisms. This is best done with qualitative methods. Their main strength is they can provide rich descriptions of the causal connections which can be the basis for a new theory. When developing these mechanisms, future research should also elaborate on the policy consequences. We stated some implications for policy, but much more work is needed to develop policies for helping high-growth companies.

One problem that this chapter does not solve is a better and more theoretically sound operationalization of barriers to growth. Future research should build on this conceptualization and develop new measures for the barriers according to the rigorous principles of scale development (Hinkin, 1998). These could then be used to collect new data and empirically examine the multilevel causal connections (proposed by the previous qualitative research) between the conditions for barriers present in entrepreneurial ecosystems and the firm-level barriers. However, this research should use NCA, QCA, or other methods that are able to incorporate the necessary conditions logic.

We developed the conceptualization of barriers on a sample of Slovenian high-tech companies. Even though our theory could be generalizable to other geographical and industry contexts, future research should examine the extent to which this is really the case. This means that our conceptualization of barriers should be assessed for other types of companies and in different geographical environments.

Finally, research on barriers to growth needs to engage with wider societal issues. One important concern is that there are systemic limits to growth as the amount of resources on the planet is limited (Meadows, Meadows, Randers, & Behrens, 1972). We know very little about how these systemic limits influence firm-level barriers. There is also a possibility that developed countries already reached the limits of economic growth as average economic growth is declining since the 1950s (Gordon, 2012). One of the main assumptions behind interest in firm growth is that encouraging higher growth on firm level would mean higher economic growth. But if an economy is not capable of further growth, firm growth essentially becomes a zero-sum game. What are the consequences of this possibility for founders and managers? Furthermore, there are increasing number of entrepreneurs that are establishing ventures for public benefit and are not primarily interested in profit and growth (Mair & Martí, 2006). Legislators around the world are supporting these developments with new organizational forms like Benefit Corporations in the USA (Hiller, 2013) and initiatives like Sistema B in South America. Growth issues in these kind of ventures need more research in order to better understand their development and impact.

GENERAL DISCUSSION AND CONCLUSION

In this final chapter, I discuss the main findings and contributions of the last three chapters. I also summarize the principal methodological and practical implications of the dissertation. In the end, I outline the limitations, establish a future research agenda and finish with concluding remarks.

Summary of the main findings and theoretical contributions

The goal of the first chapter (Bibliometric methods in management and organization) was to develop guidelines for conducting bibliometric reviews of scientific literature. The main findings stem from the review on the use of bibliometric methods in the management literature. The bibliometric methods that are most used are citation and co-citation analysis, while bibliographic coupling is used relatively little by management researchers. By far the most commonly used database is Web of Science. The most frequently used unit of analysis is document, while author and journal were less frequently used units. The findings for other coded categories are less clear. Earlier bibliometric reviews employed different selection methods, grouping methods and visualization methods. There are also no clear software choices for conducting bibliometrics and/or visualization. The lack of easy-to-use bibliometric software specifically designed for conducting bibliometric reviews became apparent when assessing the software choices.

The primary contribution of the first chapter is methodological. I established guidelines for conducting bibliometric reviews by synthesizing the use of methods in earlier bibliometric studies and the bibliometric methods literature. The guidelines were systematized in a five-step process that guides researchers from finding the appropriate research question (which can be answered by using bibliometric methods) all the way to interpreting the results (which is the most difficult part of conducting bibliometric review studies). I believe that bibliometric methods will complement the traditional structured literature reviews and meta-analyses as one of the three main methods for reviewing scientific literature.

The main goal of the second chapter was to quantitatively establish the theoretical foundations of the firm growth literature. The citation analysis clearly showed that resource-based theories are the key theoretical foundation of the firm growth literature. Even though earlier studies used different criteria to structure the literature, co-citation analysis found two main clusters: strategic entrepreneurship and economics. These two major clusters are large and influential and complemented by eight smaller clusters. This structure is based on aggregate citation practices of scholars working in the field. Several theoretical perspectives discussed in earlier reviews (e.g. managerial theory, strategic fit) were not detected by the bibliometric quantitative assessment. This fact combined with the dominance of the two

major clusters suggests that the theoretical landscape of firm growth research has become less diverse than in the past.

Quantitative support for the dominance of resource-based perspectives in the theoretical foundations is also the biggest contribution of Chapter 2. This has been hypothesized before (e.g. McKelvie & Wiklund, 2010), but this is the first time it has been established with quantitative evidence. The second contribution also aligns with the second main finding. The two clusters of literature I found are different than earlier categorizations.

The goal of the third chapter was to theoretically and empirically establish how barriers to growth constrain the growth of high-tech companies. I found five firm-level barriers to growth: finance, human capital, growth ambition, growth management knowledge, and product-market fit. The configuration of these barriers is unique to every firm and can change over time.

The main contribution of the third chapter is the thorough conceptualization of barriers to growth. The principal novelty is the conceptualization of barriers as necessary conditions for growth. The necessary conditions logic demands that all necessary conditions must be fulfilled if the firm wants to grow, but they are not enough. Chapter 3's second contribution is the extension of Spigel's (2015) model of an entrepreneurial ecosystem with the connection among ecosystem attributes and firm-level barriers to growth. This means that I also specify the causal connections between ecosystem-level factors (i.e., conditions for barriers) and firm-level barriers.

A summary of the major findings and contributions is found in Table 12.

Table 12. Summary of the main findings and contributions

Chapter	Research questions	Main findings	Main contributions
1 – Bibliometric methods in management and organization	<p>RQ1a: How are bibliometric methods used for the purpose of literature reviews in the management and organization field?</p> <p>RQ1b: What is the appropriate procedure for using bibliometric methods in literature reviews?</p>	<p>The most used bibliometric methods are citation and co-citation analysis.</p> <p>Bibliographic coupling is used relatively little by management researchers.</p> <p>The most used database is Web of Science.</p> <p>The most frequently used unit of analysis is document, while author and journal were less frequently used units.</p> <p>There are no clear software choices for conducting bibliometrics and/or visualization.</p> <p>Easy-to-use bibliometric software is unavailable.</p>	<p>Established guidelines for conducting bibliometric reviews by synthesizing the methods used in earlier bibliometric studies and the bibliometric methods literature.</p> <p>The recommendations are systematized in a five-step process that guides researchers from establishing the research question to interpreting the results.</p>
2 – Theoretical foundations of firm growth	RQ2a: What are the theoretical foundations of the firm growth research?	Resource-based theories are the main theoretical foundation of the firm growth literature.	Quantitative support for the dominance of resource-based perspectives in the theoretical foundations.

	RQ2b: What is the intellectual structure of the firm growth research?	Co-citation analysis found two main groups of literature (strategic entrepreneurship and economics) and eight smaller groups.	The structure of the firm growth research established by bibliometric analysis of citation practices is different than in earlier reviews.
	RQ2c: Is scientific progress in understanding firm growth hindered by the use of inappropriate theories?	Several theoretical perspectives discussed in previous reviews (e.g. managerial theory, strategic fit) were not detected by the bibliometric quantitative assessment.	
3 – Barriers to growth in high-tech firms	RQ3a: Are barriers to growth appropriately conceptualized?	Barriers to growth are firm-level necessary conditions for persistent growth.	The thorough conceptualization of barriers to growth.
	RQ3b: If necessary, develop the concept of barriers to growth.	There are five barriers to growth: finance, human capital, growth ambition, growth management knowledge, and product-market fit.	The principal novelty is the conceptualization of barriers as necessary conditions for growth.
	RQ3c: How do barriers to growth prevent the faster growth of high-tech companies?	The configuration of barriers is unique to every firm and can change over time. Firm-level barriers to growth are influenced by entrepreneurial ecosystem-level attributes (i.e. conditions for barriers).	The extension of Spigel's (2015) model of an entrepreneurial ecosystem with the connection among the ecosystem attributes and firm-level barriers to growth.

Summary of implications

Methodological implications

The bibliometric approach is now a valid methodological choice for conducting reviews of literature. In the first chapter, researchers can find a range of tools and recommendations for performing bibliometric reviews. Some of these tools (e.g. the method of bibliographic coupling) have been relatively neglected so far by management researchers. They should be used more as the characteristics and strengths of each method are unique. Bibliometric methods can reveal the underlying structure of scientific literature or quantitatively support specific claims about the influence or development of the analyzed research. But to truly capitalize on the capabilities of these methods, new doctoral students must be trained in bibliometric methods alongside training in how to conduct traditional structured literature reviews and meta-analyses.

In the second chapter, I urged researchers to move away from using just the RBV as a theoretical foundation for firm growth research. One implication of this suggestion is methodological. As the simple formula $\text{RESOURCES} \Rightarrow \text{GROWTH}$ is unable to explain the complicated process of growth, researchers should use: (1) qualitative methods to dig deeper into the growth process; and (2) complexity science to explain growth processes in populations of firms. The qualitative methods are capable of producing richer insights that are necessary for examining how the growth process unfolds over time and can illuminate aspects of growth that are difficult to quantify. Alternatively, complexity science principles (chaotic systems, periods of stasis punctuated by sudden changes, positive feedback, and path dependence) have the potential to reinvigorate the stages approach whose development has stalled due to insufficient empirical support. The first step towards complexity-based explanations of growth processes could be to use computer simulations, particularly agent-based modeling, in devising new models of growth.

The conceptualization of barriers to growth as necessary conditions for growth in the third chapter also holds methodological implications. Traditional statistical methods based on correlational relations (e.g. multiple regression) are unable to methodologically fulfill the requirements of the necessary conditions logic. A particular problem with traditional methods is their reliance on the (linear) additivity of the effects of determinant variables (i.e. predictors) on the outcome. The lack of one determinant can be compensated for by increasing the other determinants in the equation. Yet this is inconsistent with the necessary conditions logic which requires that all determinants must be non-zero for the outcome to exist. The lack of one cannot be compensated for by others. Therefore, methods like necessary conditions analysis (NCA) (Dul, 2016) or qualitative comparative analysis (QCA) (Fiss, 2007; Schneider & Wagemann, 2012) are more appropriate for empirically examining barriers to growth.

Practical implications

The process and recommendations for conducting bibliometric analyses of literature are not only useful for researchers, but also for employees in high-tech firms who need to translate scientific knowledge into the development of new products. Bibliometric methods are a useful tool that can give a quick overview and structure of a specific scientific field and identify the important publications within it. Further, bibliometric methods can serve to detect emerging topics in the literature (Ding & Chen, 2014). This means the methods can be used by practitioners to identify new knowledge holding potential for practical use in products and services.

While the assessment of the theoretical foundations of firm growth was primarily a theoretical endeavor, some practical lessons also emerge. First, the growth rates of firms are notoriously difficult to predict. Second, since resource-based explanations are insufficient for modeling growth, managers must look beyond resources when trying to grow their firms. I believe that considering the business model of their firm as a whole would be a more appropriate construct to leverage for growth.

The model of barriers to growth is useful for entrepreneurs to frame their strategic thinking about the long-term development and growth of their company. They need to consider all barriers holistically and systematically work on eliminating not just one but all of them in order to grow persistently. The same is true for policymakers, who should also view barriers holistically and not overfocus on a specific one – usually finance. Policymakers should also be more aware of the multilevel connections between ecosystem-level factors and firm-level barriers. Some ecosystem-level attributes (e.g. culture) change slowly and can only be influenced with prolonged effort.

Summary of the limitations and future research directions

Limitations

The review of bibliometric methods was focused on the use of these methods for mapping science. I also limited the selection of studies in the management and organization field so, if the use of methods in other fields is more diverse, I might have missed some possibilities regarding research questions, the process, visualization techniques or software used. Still, the selection includes representative studies and bibliometric practices in management and organization.

The biggest limitation of the examination of the theoretical foundations of firm growth stems from the characteristics of the bibliometric methods. They are unable to capture the intentions of scholars writing the publications. An article may be cited because it was regarded as a credible source for the study or to criticize its results. Another limitation is that

results can be influenced by the selection of journals to review: I chose to include top management and entrepreneurship journals. A different selection would likely produce different results, thus the outcome of the bibliometric assessment is valid for the firm growth research in the fields of management and entrepreneurship. The theoretical foundation findings are also only representative of research published after 2003 as I deliberately limited the timeframe to contemporary studies.

I developed the concept of barriers to growth with qualitative methods on a sample of a specific type of companies in the Slovenian geographical context. I could have missed certain barriers that are more important for other types of companies in other contexts. Researchers should thus be careful before generalizing the theory to other contexts. Further, the model of barriers to growth covers entrepreneurial ecosystem-level and firm-level factors. However, conditions on national or global levels could also influence barriers on the firm level (e.g. credit contraction in a global financial crisis). Therefore, I could have overlooked some factors on other levels that are important influences on barriers to growth.

Future research directions

I believe the biggest potential to enhance the bibliometric approach for reviewing scientific studies lies in the use of text-based methods. Machine learning research has recently made several important advances. For example, Latent Dirichlet Allocation (LDA) (Blei, 2012; Blei, Ng, & Jordan, 2003) is a method that is able to find conversational topics in large amounts of text, even so large that it is unfeasible to read them within an acceptable timeframe. LDA has only recently started to be applied to the analysis of scientific texts (e.g. Jelveh, Kogut, & Naidu, 2014). Particularly fruitful might be a combination of citation-based and text-based methods, but much more methodological research is required before we know how useful and how valid these new approaches are.

Regarding firm growth research in general, I outline five possibilities for future research. (1) A focus on Penrose's versatility of resources, which is the characteristic applicable to growth as opposed to VRIN resources, which is the characteristic applicable to creating a competitive advantage and capturing rent streams. (2) To include more demand-side considerations in future growth research. This could be done by using the business model construct with its integration of the value creation and value capture perspectives, and thus bridge the disciplinary divide between strategic entrepreneurship and marketing. (3) To refocus on the process of growth and not just the amount of growth. (4) To abandon the simplistic characterization of the connection between resources and growth, and to focus on resource orchestration. (5) More work is needed on the policy implications of empirical research on high-growth firms.

For barriers to growth in particular, there are four main avenues for proceeding with the research. First, qualitative research could delve deeper into the mechanisms by which entrepreneurial ecosystem-level factors influence barriers to growth. I specified several multilevel connections between ecosystem- and firm-level factors, but this area is currently insufficiently researched. Second, multilevel quantitative research could use the NCA, QCA or related methods to examine how much each barrier constrains growth. Third, I developed the theory with high-tech companies in mind. Future research should examine to what extent this conceptualization of barriers is generalizable to other types of companies and other contexts. Finally, barriers to growth research should engage more deeply with societal issues and systemic limits to growth.

Concluding remarks

This dissertation is my contribution to knowledge about the growth of high-tech companies. Management researchers now have a single reference to use when conducting bibliometric reviews of literature. The theoretical foundations of firm growth research, previously rarely discussed explicitly, are now illuminated. The barriers to growth model provides a concise framework for entrepreneurs to think about the long-term development of their venture. Policymakers can use it to develop holistic policies with a systemic outlook and not just piece-meal solutions that are unlikely to ignite growth. Finally, I believe the barriers to growth framework can become a platform for my future research program. There's much more work to do. Let's do it!

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APPENDICES

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Appendix A: Study selection and coding (Chapter 1)

Falling within the scope of the first chapter are studies using bibliometric methods for mapping research fields or research topics in management and organization. Using Web of Science (WOS), a search query was made for the following terms: bibliometric* OR co-citation OR bibliographic coupling OR co-author OR co-word in the topic of the entry. The search returned 5,046 entries which were further filtered for publications in the management and business domain. We then read every abstract of the remaining 381 documents. We excluded those unrelated to the scope of our research. Documents in this phase were mainly excluded for the following reasons:

- Studies conducted science mapping in fields unrelated to management or organization (e.g. nanotechnology).
- A large number of documents were excluded because their main topic was measuring the productivity of researchers, organizations or systems/countries, which is outside the scope of our research. This research stream is more concerned with measuring the productivity of scientists and a comparison/ranking of various journals, research organizations or countries than with mapping the science.
- Studies examined patents, not scientific publications; as such, they belonged to the domain of technological forecasting.
- The keyword “co-author” in a number of articles referred just to a co-author without any connection to the bibliometric method of co-author analysis.

After filtering the publications through the WOS online user interface, we downloaded the documents left in the set. Where articles were unavailable through our resources, we contacted the authors for the original manuscript. We were unable to retrieve three articles even after this step. Finally, we were left with 81 studies that constitute the publications in our data sample.

Once the list of publications had been compiled, all the manuscripts were carefully read and coded by one of the authors and a research assistant. Agreement ranged between 87.7% and 100%. The differences were reconciled in a joint session where manuscripts in question were analyzed and solutions determined. The categories were determined by the two authors to cover the main aspects of the bibliometric analysis. Coders categorized the following: (a) which bibliometric methods were utilized; (b) whether the study used multiple time periods to track the evolution of the field through time; (c) how the selection was performed; (d) which database was used as source of bibliometric data; (e) which bibliometric software was used; (f) what was the unit of analysis; (g) which methods were applied to produce subgroups; (h) which visualization method was used; and (i) which visualization software was employed.

Selected studies

Authors	Year	Publication name	Title
Pilkington & Lawton	2013	LONG RANGE PLANNING	Divided by a Common Language? Transnational Insights into Epistemological and Methodological Approaches to Strategic Management Research in English-Speaking Countries
Walter & Ribiere	2013	KNOWLEDGE MANAGEMENT RESEARCH & PRACTICE	A citation and co-citation analysis of 10 years of KM theory and practices
Vogel & Güttel	2013	INTERNATIONAL JOURNAL OF MANAGEMENT REVIEWS	The Dynamic Capability View in Strategic Management: A Bibliometric Review
Chabowski, Samiee, & Hult	2013	JOURNAL OF INTERNATIONAL BUSINESS STUDIES	A bibliometric analysis of the global branding literature and a research agenda
Muñoz-Leiva, Sánchez-Fernández, Liébana-Cabanillas, & Martínez-Fiestas	2013	THE SERVICE INDUSTRIES JOURNAL	Detecting salient themes in financial marketing research from 1961 to 2010
Coombes & Nicholson	2013	INDUSTRIAL MARKETING MANAGEMENT	Business models and their relationship with marketing: A systematic literature review
Carvalho, Fleury, & Lopes	2013	TECHNOLOGICAL FORECASTING AND SOCIAL CHANGE	An overview of the literature on technology roadmapping (TRM): Contributions and trends
Raasch, Lee, Spaeth, & Herstatt	2013	RESEARCH POLICY	The rise and fall of interdisciplinary research: The case of open source innovation
Gedsri, Kongthon, & Vatananan	2013	TECHNOLOGY ANALYSIS & STRATEGIC MANAGEMENT	Mapping the knowledge evolution and professional network in the field of technology roadmapping: a bibliometric analysis

Ferreira, Pinto, Serra, & Santos	2013	REVIEW OF BUSINESS MANAGEMENT	A Bibliometric Study of John Dunning's Contribution to International Business Research
Bernroider, Pilkington, & Córdoba	2013	JOURNAL OF INFORMATION TECHNOLOGY	Research in information systems: A study of diversity and inter-disciplinary discourse in the AIS basket journals between 1995 and 2011
Gundolf & Filser	2013	JOURNAL OF BUSINESS ETHICS	Management Research and Religion: A Citation Analysis
Benavides- Velasco, Quintana- García, & Guzmán-Parra	2013	SMALL BUSINESS ECONOMICS	Trends in family business research
Shafique	2013	STRATEGIC MANAGEMENT JOURNAL	Thinking inside the box – intellectual structure of the knowledge base of innovation research (1988-2008)
Ma, Liang, Yu, & Lee	2012	BUSINESS ETHICS: A EUROPEAN REVIEW	Most cited business ethics publications: mapping the intellectual structure of business ethics studies in 2001-2008
Wallin	2012	INNOVATION: MANAGEMENT, POLICY & PRACTICE	The bibliometric structure of spin-off literature
Leone, Robinson, Bragge, & Somervuori	2012	JOURNAL OF BUSINESS RESEARCH	A citation and profiling analysis of pricing research from 1980 to 2010
Di Guardo & Harrigan	2012	JOURNAL OF TECHNOLOGY TRANSFER	Mapping research on strategic alliances and innovation: a co-citation analysis
Vogel	2012	ORGANIZATION STUDIES	The Visible Colleges of Management and Organization Studies: A Bibliometric Analysis of Academic Journals
Di Stefano, Gambardella, & Verona	2012	RESEARCH POLICY	Technology push and demand pull perspectives in innovation studies: Current findings and future research directions
Nosella, Cantarello, & Filippini	2012	STRATEGIC ORGANIZATION	The intellectual structure of organizational ambidexterity: A bibliographic investigation into the state of the art
Keupp, Palmié, & Gassmann	2012	INTERNATIONAL JOURNAL OF	The Strategic Management of Innovation: A Systematic Review and Paths for Future Research

MANAGEMENT
REVIEWS

Fagerberg, Fosaas & Sapprasert	2012	RESEARCH POLICY	Innovation: Exploring the knowledge base
Martin, Nightingale, & Yegros-Yegros	2012	RESEARCH POLICY	Science and technology studies: Exploring the knowledge base
Martin	2012	RESEARCH POLICY	The evolution of science policy and innovation studies
Bhupatiraju, Nomaler, Triulzi & Verspagen	2012	RESEARCH POLICY	Knowledge flows – Analyzing the core literature of innovation, entrepreneurship and science and technology studies
Landström, Harirchi & Åström	2012	RESEARCH POLICY	Entrepreneurship: Exploring the knowledge base
Hanisch & Wald	2012	PROJECT MANAGEMENT JOURNAL	A Bibliometric View on the Use of Contingency Theory in Project Management Research
Samiee & Chabowski	2012	JOURNAL OF THE ACADEMY OF MARKETING SCIENCE	Knowledge structure in international marketing: A multi-method bibliometric analysis
Ronda-Pupo & Guerras- Martin	2012	STRATEGIC MANAGEMENT JOURNAL	Dynamics of the evolution of the strategy concept 1962-2008: a co-word analysis
Montiel Campos, Sole Parella & Palma	2012	RBGN-REVISTA BRASILEIRA DE GESTAO DE NEGOCIO	Mapping the Intellectual Structure of Entrepreneurship Research: revisiting the invisible college
Calabretta, Durisin, & Ogliengo	2011	JOURNAL OF BUSINESS ETHICS	Uncovering the Intellectual Structure of Research in Business Ethics: A Journey Through the History, the Classics, and the Pillars of Journal of Business Ethics
Tu	2011	AFRICAN JOURNAL OF BUSINESS MANAGEMENT	A study of influential authors, works and research network of consumer behavior research

Shilbury	2011	JOURNAL OF SPORT MANAGEMENT	A Bibliometric Study of Citations to Sport Management and Marketing Journals
Chabowski, Hult, et al.	2011	JOURNAL OF RETAILING	The Retailing Literature as a Basis for Franchising Research: Using Intellectual Structure to Advance Theory
Backhaus, Luegger, & Koch	2011	INDUSTRIAL MARKETING MANAGEMENT	The structure and evolution of business-to-business marketing: A citation and co-citation analysis
Herbst, Voeth, & Meister	2011	INDUSTRIAL MARKETING MANAGEMENT	What do we know about buyer-seller negotiations in marketing research? A status quo analysis
Kraus	2011	AFRICAN JOURNAL OF BUSINESS MANAGEMENT	State-of-the-art current research in international entrepreneurship: A citation analysis
Fischbach et al.	2011	ELECTRONIC MARKETS	Co-authorship networks in electronic markets research
Chabowski, Mena, et al.	2011	JOURNAL OF THE ACADEMY OF MARKETING SCIENCE	The structure of sustainability research in marketing, 1958-2008: a basis for future research opportunities
Huang & Ho	2011	AFRICAN JOURNAL OF BUSINESS MANAGEMENT	Historical research on corporate governance: A bibliometric analysis
Galvagno	2011	EUROPEAN JOURNAL OF MARKETING	The intellectual structure of the anti-consumption and consumer resistance field: An author co-citation analysis
Marsilio et al.	2011	PUBLIC MANAGEMENT REVIEW	The Intellectual Structure of Research Into PPPS: A bibliometric analysis
Chang & Ho	2010	AFRICAN JOURNAL OF BUSINESS MANAGEMENT	Bibliometric analysis of financial crisis research
Raghuram, Tuertscher, & Garud	2010	INFORMATION SYSTEMS RESEARCH	Mapping the Field of Virtual Work: A Cocitation Analysis
Di Stefano et al.	2010	INDUSTRIAL AND CORPORATE CHANGE	Dynamic capabilities deconstructed: a bibliographic investigation into the origins, development, and future directions of the research domain

Baumgartner	2010	JOURNAL OF CONSUMER PSYCHOLOGY	Bibliometric reflections on the history of consumer research
Volberda, Foss, & Lyles	2010	ORGANIZATION SCIENCE	Absorbing the Concept of Absorptive Capacity: How to Realize Its Potential in the Organization Field
Durisin, Calabretta, & Parmeggiani	2010	JOURNAL OF PRODUCT INNOVATION MANAGEMENT	The Intellectual Structure of Product Innovation Research: A Bibliometric Study of the Journal of Product Innovation Management, 1984-2004
Uysal	2010	JOURNAL OF BUSINESS ETHICS	Business Ethics Research with an Accounting Focus: A Bibliometric Analysis from 1988 to 2007
Ma & Yu	2010	JOURNAL OF KNOWLEDGE MANAGEMENT	Research paradigms of contemporary knowledge management studies: 1998-2007
Ma	2009	JOURNAL OF BUSINESS ETHICS	The Status of Contemporary Business Ethics Research: Present and Future
Pilkington & Meredith	2009	JOURNAL OF OPERATIONS MANAGEMENT	The evolution of the intellectual structure of operations management – 1980-2006: A citation/co-citation analysis
Uslay, Morgan, & Sheth	2009	JOURNAL OF THE ACADEMY OF MARKETING SCIENCE	Peter Drucker on marketing: an exploration of five tenets
Artto, Martinsuo, Gemuendne, & Murtoaro	2009	INTERNATIONAL JOURNAL OF PROJECT MANAGEMENT	Foundations of program management: A bibliometric view
Kim & McMillan	2008	JOURNAL OF ADVERTISING	Evaluation of Internet advertising research – A bibliometric analysis of citations from key sources
Nerur et al.	2008	STRATEGIC MANAGEMENT JOURNAL	The intellectual structure of the strategic management field: An author co-citation analysis
Ma, Lee, & Yu	2008	INTERNATIONAL JOURNAL OF CONFLICT MANAGEMENT	Ten years of conflict management studies: themes, concepts and relationships
Pilkington & Chai	2008	INTERNATIONAL JOURNAL OF	Research themes, concepts and relationships – A study of International Journal of Service Industry Management (1990-2005)

SERVICE INDUSTRY
MANAGEMENT

Charvet, Cooper, & Gardner	2008	JOURNAL OF BUSINESS LOGISTICS	The intellectual structure of supply chain management: A bibliometric approach
McMillan	2008	R & D MANAGEMENT	Mapping the invisible colleges of R&D Management
Casillas & Acedo	2007	FAMILY BUSINESS REVIEW	Evolution of the intellectual structure of family business literature: A bibliometric study of FBR
Biemans, Griffin, & Moenaert	2007	JOURNAL OF PRODUCT INNOVATION MANAGEMENT	Twenty years of the Journal of product innovation management: History, participants, and knowledge stock and flows
Acedo, Barroso, Casanueva, & Galan	2006	JOURNAL OF MANAGEMENT STUDIES	Co-authorship in management and organizational studies: An empirical and network analysis
Acedo, Barroso, & Galan	2006	STRATEGIC MANAGEMENT JOURNAL	The resource-based theory: Dissemination and main trends
Gregoire, Noel, Dery, & Bechard	2006	ENTREPRENEURSHIP THEORY AND PRACTICE	Is there conceptual convergence in entrepreneurship research? A co-citation analysis of Frontiers of Entrepreneurship Research, 1981-2004
Cornelius, Landstrom, & Persson	2006	ENTREPRENEURSHIP THEORY AND PRACTICE	Entrepreneurial studies: The dynamic research front of a developing social science
Schildt, Zahra, Sillanpaa	2006	ENTREPRENEURSHIP THEORY AND PRACTICE	Scholarly communities in entrepreneurship research: A co-citation analysis
Reader & Watkins	2006	ENTREPRENEURSHIP THEORY AND PRACTICE	The social and collaborative nature of entrepreneurship scholarship: A co-citation and perceptual analysis
Pilkington & Teichert	2006	TECHNOVATION	Management of technology: themes, concepts and relationships
Cornelius & Persson	2006	TECHNOVATION	Who's who in venture capital research
Pilkington & Fitzgerald	2006	INTERNATIONAL JOURNAL OF OPERATIONS &	Operations management themes, concepts and relationships: a forward retrospective of IJOPM

PRODUCTION
MANAGEMENT

Acedo & Casillas	2005	INTERNATIONAL BUSINESS REVIEW	Current paradigms in the international management field: An author co-citation analysis
Neely	2005	INTERNATIONAL JOURNAL OF OPERATIONS & PRODUCTION MANAGEMENT	The evolution of performance measurement research – Developments in the last decade and a research agenda for the next
Meyer, Pereira, Persson, & Granstrand	2004	RESEARCH POLICY	The scientometric world of Keith Pavitt – A tribute to his contributions to research policy and patent analysis
Ramos-Rodriguez & Ruiz-Navarro	2004	STRATEGIC MANAGEMENT JOURNAL	Changes in the intellectual structure of strategic management research: A bibliometric study of the Strategic Management Journal, 1980-2000
Phillips, Baumgartner, & Pieters	1999	ADVANCES IN CONSUMER RESEARCH, VOL 26	Influence in the evolving citation network of the journal of consumer research
Pilkington & Liston-Heyes	1999	INTERNATIONAL JOURNAL OF OPERATIONS & PRODUCTION MANAGEMENT	Is production and operations management a discipline? A citation/co-citation study
Pasadeos, Phelps, & Kim	1998	JOURNAL OF ADVERTISING	Disciplinary impact of advertising scholars: Temporal comparisons of influential authors, works and research networks
Urdiken & Pasadeos	1995	ORGANIZATION STUDIES	Organizational analysis in North-America and Europe – a comparison of cocitation networks
Hoffman & Holbrook	1993	JOURNAL OF CONSUMER RESEARCH	The intellectual structure of consumer research – a bibliometric study of author cocitations in the 1st 15 years of the Journal of Consumer Research

Appendix B: Exact steps to reproduce a bibliometric analysis of the ORM journal (Chapter 1)

1. Select and download data from the Web of Science website
 - a. Go to WOS website apps.webofknowledge.com (subscription needed, often included in university library access)
 - b. Select “Web of Science Core Collection” (this step is needed to be able to export cited references)
 - c. Search for “Organizational Research Methods” in Publication Name
 - d. Exclude publication year 1998 (since the years 1999 and 2000 are missing from Web of Science records we will perform the analysis on papers published since 2001) – 465 records are left
 - e. Export bibliometric data – Select “Save to Other File Formats”
 - f. Choose record numbers from 1 to 465 (the WoS interface enables the export of up to 500 records. If the search returns more than 500 records, each batch of 500 has to be exported separately: 1-500, 501-1000 etc. Files can be later combined in WordPad or another text processor.)
 - g. Choose Record Content: “Full Record and Cited References”
 - h. Choose File Format: “Plain Text”
 - i. Click Send and save to file “orm.txt”
2. Perform bibliometric analysis in BibExcel
 - a. Open the file “orm.txt” in the BibExcel software
 - b. File preprocessing (these steps are outlined in the BibExcel PowerPoint tutorial “Mapping science using Bibexcel and Pajek”
 - i. Replace line feeds with the carriage return – BibExcel->Edit doc-file->Replace line feed with carriage return
 - ii. Convert to the Dialog format – BibExcel-> Misc->Convert to Dialog format->Convert from Web of Science
 - iii. Process the cited references data into an intermediate .out file for co-citation analysis– Select “Any ; separated field” as the field to be analyzed, put “CD” into the Old tag field. Press the “Prep” button.
 - iv. Process the author names to keep only the first initial
BibExcel->Edit out-file->Keep only author’s first initial
 - v. Process the cited references - BibExcel->Edit out-file->Convert Upper Lower Case->Good for Cited reference strings
 - c. Perform citation analysis for journals, first authors and documents

- i. Get the top cited journals - BibExcel->Select type of unit “Cited journal”; Check the “Sort descending” option; press the Start button.
 - ii. Save the file with the top cited journals - rename the “orm.cit” file “orm-journal.cit”.
 - iii. Clean the data for the top cited journals – add citation counts for journals that are represented with several different strings
 - iv. Get the top cited documents - BibExcel->Select type of unit “Whole string”; press the Start button.
 - v. Save the file with the top cited documents - rename the “orm.cit” file “orm-document.cit”.
 - vi. Clean the data for the top cited documents – add citation counts for documents that are represented with several different strings.
- d. Perform co-citation analysis with document as the unit of analysis.
- i. Establish the citation threshold on which to perform the co-citation analysis. We decided to establish the cut-off point at 9 citations, meaning we are doing co-citation analysis on the top 112 cited documents.
 - ii. Double-click on the orm.cit file; keep only the first 112 entries in the window “The List”.
 - iii. Initiate co-citation frequency counts – first click on the orm.low file, then BibExcel->Analyze->Co-occurrence->Make pairs via listbox (first No, then OK).
 - iv. Produce a square co-citation frequency matrix that will be later analyzed with PCA – Keep only the first 77 entries in the window “The List”; click on the orm.coc file; BibExcel->Analyze->Make a matrix for MDS etc.
 - v. Open the square matrix “orm.ma2” file in Microsoft Excel, transpose the column headers to row labels (first column), save as “orm.csv”.
 - vi. Export the co-citation network in the Pajek format, this can be later imported into any network analysis software – select the “orm.coc” file and choose BibExcel->Mapping->Create net-file for Pajek.
3. Find subgroups and visualize the network in Pajek.
- a. Open file “orm.net” in Pajek – Pajek->Networks->Read network

- b. Implement Louvain algorithm to find subgroups – Pajek->Create Partition->Communities->Louvain Method->Multilevel Coarsening + Single Refinement (Resolution parameter = 1.5)
- c. Extract each subgroup into separate network – Pajek->Operations->Network+Partition->Extract Subnetwork
- d. Draw each subgroup as separate network – Pajek->Draw->Network
- e. Use Kamada-Kawai algorithm for network visualization – Pajek(drawing)->Layout->Energy->Kamada-Kawai->Free

Appendix C: Questionnaire for interviews with high-tech firms (in Slovene)

Ta pogovor je del raziskovalnega projekta o ovirah pri rasti visokotehnoloških podjetij. Zbrani podatki bodo anonimizirani. V končnem poročilu bom lahko uporabil kakšen izsek iz pogovora, ampak ga ne bom pripisal točno določeni osebi ali podjetju.

Ali lahko pogovor snemam? (DA/NE)

Ali lahko za začetek na kratko opišete podjetje in njegove ustanovitelje?

Ali lahko opišete rast podjetja do zdaj?

Ali so bile v dozdajšnji rasti kakšne prelomne točke?

Kakšne so bile vaše začetne ambicije po rasti, velikosti podjetja?

Hitra ali zmerna rast? Ste želeli zrasti čim hitreje ali ste si postavljali omejitve?

Kaj je za vas kot podjetnika rast podjetja? Kako jo merite?

Kaj so bili največji problemi/izzivi pri rasti do zdaj?

- Finančni; ali ste želeli pridobiti/uspešno pridobili zunanja sredstva – posojila, kapital?
- Organizacijski problemi?
- Zaposlovanje primernih ljudi; Izzivi zaposlovanja pri hitri rasti; odhajanje v tujino?
- Organizacijska kultura?
- Pomanjkanje povezav/«networka»?
- Marketinški izzivi?
- Managerska znanja?
- Zunanje okolje (birokracija, korupcija, ...) ?
- Drugi izzivi?

Kateri izzivi so najbolj aktualni v tem trenutku? Kateri izzivi/problemi bodo najbolj aktualni v prihodnje?

Kaj po vašem mnenju najbolj pozitivno vpliva na rast podjetja?

Kaj bi lahko v Sloveniji storili, da bi imeli več hitrorastočih firm?

Kaj bi še želeli povedati?

Appendix F: Summary in Slovenian language/Daljši povzetek disertacije v slovenskem jeziku

Opis znanstvenega področja

Vse odkar je Edith Penrose (1959) ugotovila, da viri podjetja neposredno vplivajo na njegovo rast, je rast podjetja posebej zanimala raziskovalce s področja managementa (npr. Delmar, Davidsson, & Gartner, 2003; McKelvie & Wiklund, 2010; Wright & Stigliani, 2013). Raziskovalci so obravnavali vprašanja, kako psihološke karakteristike podjetnikov in managerjev (npr. Smith, Baum, & Locke, 2001), panožne specifike (npr. Evans, 1987), strateške zveze (npr. Stuart, 2000) in razpoložljivi viri (npr. Cooper, Gimeno-Gascon, & Woo, 1994) vplivajo na hitrost in način rasti podjetij. Z analizo vzročnih predhodnikov rasti podjetja so raziskovalci poskušali odgovoriti na vprašanja, zakaj nekatera podjetja rastejo hitreje od drugih in ali hitrejša rast pripomore h končnemu uspehu organizacije (Davidsson et al., 2009). Poleg tega je fenomen rasti interes snovalcev vladnih politik vse od Birchevih (1987) prelomnih ugotovitev, da je manjšina hitrorastočih podjetij odgovorna za večino novih delovnih mest v gospodarstvu.

Zaradi vitalnosti in dinamičnosti številnih raziskav s področja rasti je več avtorjev poskušalo povezati ugotovitve v nedavnih pregledih literature (Coad, 2009; Davidsson et al., 2010; Gilbert et al., 2006; Henrekson & Johansson, 2010; Levie & Lichtenstein, 2010; McKelvie & Wiklund, 2010). Ugotavljajo, da je kljub številnim študijam s področja rasti dejanskih ugotovitev presenetljivo malo. Raziskovalci ne najdejo skupnega odgovora, kaj rast točno je – je to rezultat procesa ali vmesna stopnja v razvoju podjetja. Prav tako še ni jasnega odgovora na vprašanje, kateri so tisti vzročni dejavniki, ki vodijo v hitrejšo rast. Tudi vloga načina rasti (npr. organske rasti, rasti z akvizicijami) je še nejasna. Raziskovalci so do sedaj to pomanjkanje jasnih odgovorov pripisovali metodološkim pomanjkljivostim (Davidsson et al., 2010), vseeno pa se lahko vprašamo, ali so morda vzrok napačne teorije, ki se uporabljajo v raziskavah in ki morda niso najprimernejše za razlago rasti podjetja. Zato je potrebna temeljita analiza teoretičnih osnov in intelektualne strukture raziskav rasti.

Ovire pri rasti podjetij so notranji in zunanji dejavniki, ki omejujejo potencial rasti v podjetjih, ki želijo rasti (Storey, 1994:154). Razmerje, v kolikšni meri so ovire pri rasti za podjetje interne (npr. pomanjkanje virov) oziroma eksterne (npr. pomanjkanje usposobljenega kadra na trgu dela), je eno od osrednjih vprašanj v literaturi. Lahko so klasificirane kot institucionalne, organizacijske, finančne, tržne in družbene (Bartlett & Bukvič, 2001). Na notranje ovire vplivajo managerji in lastniki podjetij, zunanje ovire pa so domena vladnih politik in podjetniškega podpornega okolja.

Velik del literature o ovirah pri rasti je geografsko osredotočen na tranzicijske vzhodnoevropske države. Raziskovali so jih v Litvi (Aidis, 2005), Albaniji (Hashi, 2001;

Xheneti & Bartlett, 2012), na Kosovu (Hoxha & Capelleras, 2010), v Sloveniji (Bartlett & Bukvič, 2001), Rusiji (Rachel Doern, 2009) in Bolgariji (Pissarides et al., 2003). Druge raziskave so osredotočene na države v razvoju (Coad & Tamvada, 2012; Das & Das, 2014; Robson & Obeng, 2008) oziroma specifične kontekste v razvitih državah (Lee & Cowling, 2013).

Za panogo IKT (informacijske in komunikacijske tehnologije) so značilne dinamičnost, hitrost sprememb in turbulentnost. Digitalna podjetja lahko rastejo izredno hitro. Podjetja, ustanovljena pred manj kot dvajsetimi leti so zdaj med največjimi na svetu (npr. Facebook, Google). Tempo sprememb, konkurenčnost, neprestan razvoj, tehnološki napredek, kratki življenjski cikli proizvodov in velik pomen nekaterih ekonomskih sil, kot so mrežni učinki, stroški zamenjave, naraščajoči donosi obsega, so karakteristike okolja, ki jih morajo managerji visokotehnoloških podjetij upoštevati. Visokotehnološke panoge so tiste, v katerih "zmagovalec pobere vse" (Viardot, 2004). Zato je kontekst visokotehnoloških IKT-podjetij specifičen in vreden posebne obravnave.

Namen, cilji, raziskovalna vprašanja in raziskovalne metode doktorske disertacije

Namen te disertacije je prispevati k znanju o rasti podjetij, posebej v kontekstu visokotehnoloških podjetij v IKT panogi. Ta kontekst je bistvenega pomena za gospodarski uspeh in tehnološki napredek. Novo kreirano znanje v tej disertaciji lahko pomaga podjetnikom bolje obvladovati rast njihovih podjetij. Poleg tega je tudi v pomoč snovalcem vladnih politik pri oblikovanju ukrepov, ki ciljajo visokotehnološka hitrorastoča podjetja.

V tabeli 1 predstavim glavne raziskovalne cilje, raziskovalna vprašanja in raziskovalne metode za vsako od treh glavnih vsebinskih poglavij doktorske disertacije.

Tabela 1. Pregled raziskovalnih ciljev, raziskovalnih vprašanj in raziskovalnih metod.

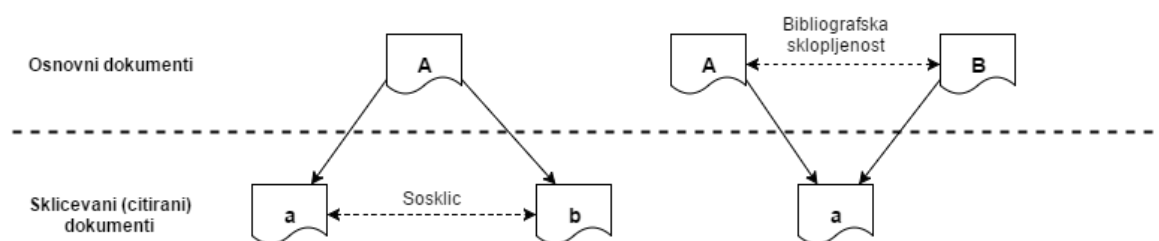
Poglavje	Raziskovalni cilj	Raziskovalna vprašanja	Raziskovalne metode
1 – Bibliometrične metode v managementu in organizaciji	RC1: Razviti smernice za uporabo bibliometričnih metod pri pregledih literature.	RV1a: Kako se bibliometrične metode uporabljajo pri pregledih literature na področju managementa in organizacije? RV1b: Kakšen je primeren proces za uporabo bibliometričnih metod pri pregledih literature?	Pregled literature Sinteza
2 – Teoretične osnove rasti podjetij	RC2: Kvantitativno vzpostaviti teoretične osnove znanstvene literature o rasti podjetij.	RV2a: Katere so teoretične osnove raziskovalnega področja rasti podjetij? RV2b: Kakšna je intelektualna struktura raziskovalnega področja rasti podjetij? RV2c: Ali je znanstveni napredek pri razumevanju rasti podjetij oviran zaradi uporabe neprimernih teorij?	Analiza sklicev Analiza sosklicev Analiza omrežij Sinteza
3 – Ovire pri rasti visokotehnoloških podjetij	RC3: Teoretično in empirično vzpostaviti, kako ovire za rast omejujejo rast visokotehnoloških podjetij.	RV3a: Ali so ovire za rast primerno definirane? RV3b: Če je potrebno, razvij koncept ovir pri rasti. RV3c: Kako ovire za rast preprečujejo rast visokotehnoloških podjetij?	Pregled literature Delno strukturirani intervjuji Opazovanje Utemeljena gradnja teorije Razvoj koncepta

1 Bibliometrične metode v managementu in organizaciji

V prvem poglavju želim ustvariti referenco in priporočila za raziskovalce, ki nameravajo uporabiti bibliometrične metode v pregledih literature na področju managementa in organizacije. Take metode povečajo objektivnost v pregledih literature in lahko tudi omejijo pristranskost raziskovalcev, ki pregledujejo literaturo. Z bibliometričnimi metodami je mogoče povzeti in vizualizirati znanstvena področja. Hkrati predstavim priporočila in razvijem postopek uporabe teh metod za povzemanje literature (analiza sklicev, analiza sosklicev, bibliografska sklopljenost, analiza soavtorstva in druge), saj bodo v prihodnosti, poleg metaanalize in strukturiranega literarnega povzetka, postale ena od treh glavnih metod za povzemanje znanstvene literature na področju managementa in organizacije.

Razlika med dvema glavnima bibliometričnima metodama, analizo sosklicev in bibliografsko sklopljenostjo je podana v sliki 1.

Slika 1. Analiza sosklicev in bibliografska sklopljenost.



V tabeli 2 povzamem bibliometrične metode, njihove značilnosti in glavne prednosti in slabosti.

Tabela 2. Povzetek glavnih bibliometričnih metod.

Metoda	Opis	Enota analize	Prednosti	Slabosti
Analiza sklicev	Ocenjuje vplivnost dokumentov, avtorjev in revij skozi frekvence sklicev (citatov).	dokument avtor revija	Lahko hitro identificira pomembna dela na znanstvenem področju.	Novejše objave niso tako citirane, zato frekvenca sklicev (citatov) nekoliko favorizira starejše objave.
Analiza sosklicev	Poveže dokumente, avtorje ali revije na podlagi skupnega pojavljanja v sklicevani literaturi znanstvenih člankov.	dokument avtor revija	Je najbolj uporabljana in validirana bibliometrična metoda. Povezovanje dokumentov, avtorjev in revij na podlagi sosklicev se je izkazalo kot zanesljivo. Ker je frekvenca sklicev merilo vplivnosti, se lahko s tem kriterijem izbere najpomembnejša znanstvena dela.	Analiza sosklicev se izvaja na sklicevani (citirani) literaturi, zato ni optimalna za mapiranje sodobne literature. Akumulacija sklicev potrebuje čas, zato najnovejših objav ni mogoče povezati neposredno, ampak samo skozi sklicevano literaturo. Več sklicev je potrebnih za zanesljivo delovanje metode, zato z njo ni mogoče mapirati literature, ki ni sklicevana (citirana). V bazi SSCI (WOS) je na voljo le informacija o prvem avtorju, zato je analiza sosklicev avtorjev omejena.
Bibliografska sklopljenost	Povezuje dokumente, avtorje ali revije na podlagi števila skupnih referenc v sklicevani literaturi.	dokument avtor revija	Na voljo takoj, ne potrebuje akumulacije sklicev (citatov). Lahko se uporablja za novejše publikacije, ki še niso citirane, za novejša in manjša znanstvena področja.	Lahko se uporablja za omejen časovni interval analize (do pet let). Sama po sebi ne identificira pomembnih del. Težko je vedeti, ali je neka publikacija pomembna ali ne.
Analiza soavtorstva	Povezuje soavtorje v znanstvenem članku.	avtor	Lahko pokaže sodelovanje med avtorji in mapira družbeno strukturo področja.	Sodelovanje ni vedno priznано s soavtorstvom.

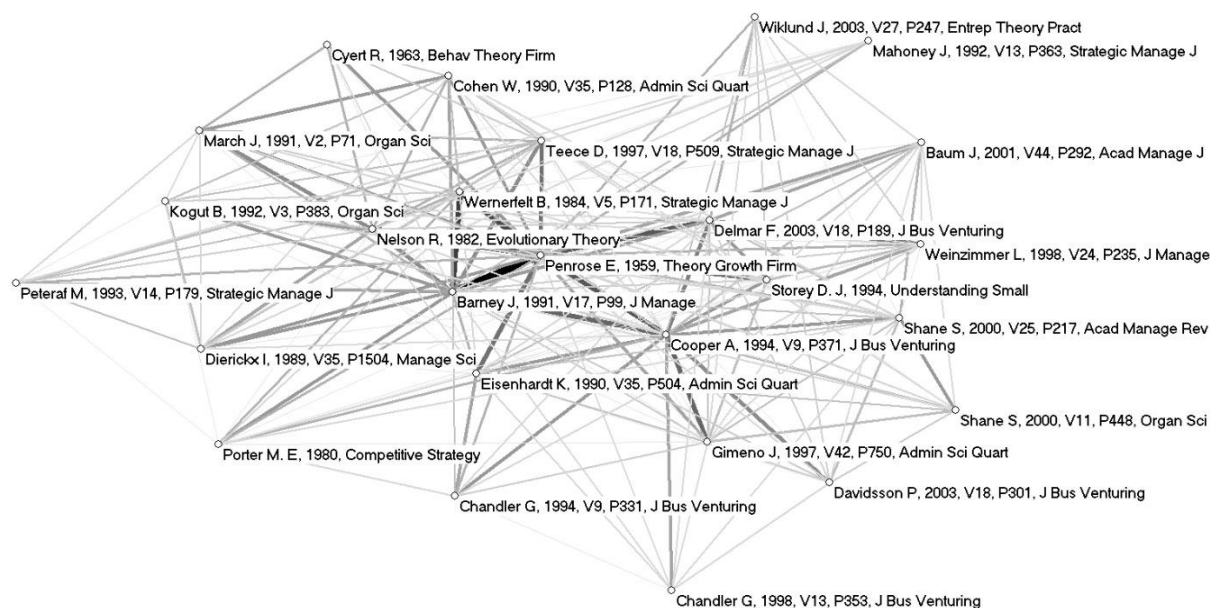
Analiza sobesedila	Povezuje ključne besede v naslovih in povzetkih.	ključna beseda	Uporablja dejansko tekstovno vsebino dokumentov.	Besede se lahko pojavljajo v različnih oblikah. Enake besede imajo lahko različen pomen.
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2 Teoretične osnove rasti podjetij

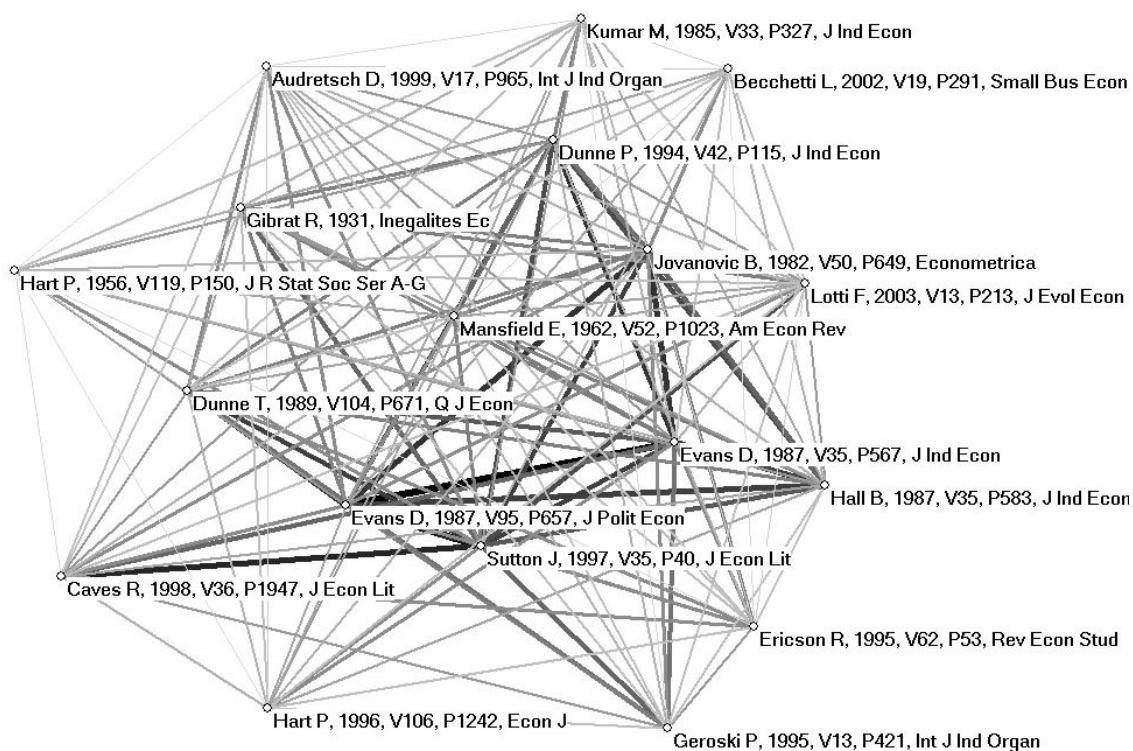
Postopek in priporočila za uporabo bibliometričnih metod, ki jih razvijem v prvem poglavju, uporabim v drugem poglavju. Z bibliometrično metodo analize sklicev in analize sosklicev identificiram teoretične temelje rasti podjetij. Ugotovim, da razlage na podlagi teorije virov najpogosteje uporabljajo v sodobnih znanstvenih raziskavah rasti podjetij. Identificiram deset skupin teoretičnih temeljev. Dominantni dve sta: (1) strateško podjetništvo, tesno povezano s teorijo virov in sorodnimi teorijami, in (2) ekonomski temelji, ki so večinoma empirični in ateoretični. Preostalih osem skupin je odraz raznolikosti in fragmentacije raziskovalnega področja. Iz rezultatov analize razvijem raziskovalni program, ki bo koristil prihodnjim raziskavam. Glavni skupini teoretičnih temeljev sta za zdaj precej nepovezani. Večja integracija bi koristila raziskavam iz obeh skupin.

Na slikah 2 in 3 sta prikazani glavni skupini teoretičnih osnov rasti podjetij.

Slika 2. Teoretične osnove rasti podjetij – strateško podjetništvo.



Slika 3. Teoretične osnove rasti podjetij – ekonomija.



3 Ovire pri rasti visokotehnoloških podjetij

Kritiki znanstvene literature o ovirah pri rasti izpostavljajo nerazvitost in prešibko teoretično utemeljenost. V tretjem poglavju natančno definiram ovire pri rasti kot faktorje znotraj podjetja, ki so potrebni pogoji za rast. Identificiram pet ovir za rast: finance, človeški kapital, ambicije po rasti, znanje o managementu rasti in ujemanje produkta in trga. Logika potrebnih pogojev zahteva, da mora biti, če podjetje želi hitro rasti skozi daljše obdobje, izpolnjenih vseh pet pogojev. Ugotovitve temeljijo na dvaintridesetih intervjujih s tehnološkimi podjetniki, svetovalci in predstavniki podpornega okolja, podatkih iz trimesečnega opazovanja generacije visokotehnoloških startupov v podjetniškem pospeševalniku in obstoječi znanstveni literaturi. Ovire pri rasti postavim v okvir Spiglovega (2015) modela podjetniškega ekosistema in natančno določim, kako faktorji na nivoju podjetniškega ekosistema vplivajo na ovire pri rasti na nivoju podjetja.

Povzetek ugotovitev in doprinosa doktorske disertacije

Cilj prvega poglavja (Bibliometrične metode v managementu in organizaciji) je bil razviti priporočila za uporabo bibliometričnih metod v pregledih znanstvene literature. Glavne ugotovitve izvirajo iz pregleda uporabe bibliometričnih metod v management literaturi.

Najbolj uporabljani bibliometrični metodi sta analiza sklicev in analiza sosklicev, medtem ko bibliografsko sklopljenost raziskovalci na področju managementa le redko uporabljajo. Daleč najbolj uporabljena baza podatkov je Web of Science. Najbolj pogosto uporabljena enota analize je dokument, manj uporabljena sta avtor in revija. Ugotovitve ostalih kodiranih kategorij so manj jasne. Objavljene bibliometrične študije so uporabljale različne metode za selekcijo dokumentov, določanje strukture in vizualizacijo. Prav tako ni nedvoumne prve izbire za programsko opremo za bibliometrično analizo in/ali vizualizacijo. Pomanjkanje programske opreme, ki je enostavna za uporabo in namenjena specifično za bibliometrični pregled literature, je postalo očitno ob ocenjevanju možnosti, ki jih ponuja obstoječa programska oprema.

Glavni znanstveni prispevek prvega poglavja je metodološki. Vzpostavil sem priporočila za uporabo bibliometričnih metod v pregledih literature s sintezo uporabe metod v objavljenih bibliometričnih študijah z metodološko literaturo s področja bibliometrike. Priporočila sem sistematiziral v petstopenjskem procesu, ki vodi raziskovalca od zasnove raziskovalnega vprašanja (ki ga lahko pojasnimo z bibliometričnimi metodami) do interpretacije rezultatov (ki je najtežji del bibliometričnih študij). Verjamem, da bodo bibliometrične metode dopolnjevale tradicionalen strukturiran pregled literature in metaanalizo kot ena od treh glavnih metod za pregledovanje znanstvene literature.

Glavni cilj drugega poglavja je bil kvantitativno vzpostaviti teoretične temelje znanstvene literature s področja rasti podjetij. Analiza citatov je nedvoumno pokazala, da so razlage na podlagi teorije virov glavna teoretična osnova rasti podjetij v znanstveni literaturi. Kljub temu, da so prejšnje študije uporabljale različne kriterije za kategoriziranje literature, je analiza sosklicev našla glavni skupini študij: strateško podjetništvo in ekonomijo. Ti dve veliki in vplivni skupini dopolnjuje osem manjših skupin. Ta struktura temelji na agregaciji sklicev literature znanstvenikov, ki raziskujejo področje rasti podjetij. Nekatere teoretične perspektive, ki so bile izpostavljene v prejšnjih pregledih literature (npr. strateško ujemanje, managerska teorija), niso bile zaznane s kvantitativno bibliometrično analizo. Ta ugotovitev, kombinirana z dominacijo dveh glavnih skupin, kaže, da se je raznovrstnost teoretičnih pristopov študij rasti podjetij v primerjavi s preteklostjo pravzaprav zmanjšala.

Kvantitativna podpora ugotovitvi, da so perspektive, ki temeljijo na teoriji virov (Barney, 1991; Penrose, 1959), glavna teoretična osnova raziskavam s področja rasti podjetij, je tudi glavni znanstveni prispevek drugega poglavja. To je bilo postavljeno kot hipoteza že prej (npr. McKelvie & Wiklund, 2010), zdaj pa je prvič, da je ta ugotovitev vzpostavljena na podlagi kvantitativnih dokazov. Drugi prispevek tega poglavja se hkrati ujema z drugo ugotovitvijo o strukturi literature, ki je drugačna od prejšnjih kategorizacij.

Cilj tretjega poglavja je bil teoretično in empirično vzpostaviti, kako ovire za rast omejujejo rast visokotehnoloških podjetij. Našel sem pet glavnih ovir za rast: finance, človeški kapital, ambicije po rasti, znanje o managementu rasti in ujemanje produkta in trga. Logika potrebnih pogojev zahteva, da mora biti, če podjetje želi hitro rasti skozi daljše obdobje, izpolnjenih vseh pet pogojev. Konfiguracija petih pogojev je unikatna za vsako podjetje in se skozi čas spreminja.

Glavni znanstveni prispevek tretjega poglavja so na novo definirane ovire za rast podjetij. Glavna novost je definicija ovir kot potrebnih pogojev za rast. Ta logika predvideva, da morajo biti, če podjetje želi rasti, izpolnjeni vsi potrebni pogoji. Ti pa niso dovolj, da bi podjetje dejansko rastlo. Drugi prispevek tega poglavja je razširitev Spiglovega (2015) modela podjetniškega ekosistema s povezavo med lastnosti ekosistema in ovirami za rast na nivoju podjetja. To pomeni, da sem opisal vzročno-posledične povezave med ekosistemskimi dejavniki in notranjimi dejavniki v podjetju.

Metodološke posledice

Bibliometrični pristopi so zdaj priznana metodološka izbira za pregledovanje znanstvene literature. V prvem poglavju lahko raziskovalci najdejo številna orodja in priporočila za bibliometrične preglede literature. Nekatera od teh orodij (npr. bibliografska sklopljenost) so do zdaj raziskovalci s področja managementa zapostavljali. V prihodnje bi jih lahko pogosteje uporabljali, saj so značilnosti in dobre strani vsake metode unikatne. Bibliometrične metode lahko razkrijejo strukturo literature ali kvantitativno podprejo specifične trditve o vplivu in razvoju analizirane literature. Če želimo na področju managementa res izkoristiti vse možnosti, ki jih te metode ponujajo, morajo doktorske šole priskrbeti novim študentov ustrezno metodološko izobraževanje, ki mora potekati vzporedno z izobraževanjem v izvedbi tradicionalnih strukturiranih pregledov literature in metaanaliz.

V drugem poglavju sem priporočil raziskovalcem, naj ne uporabljajo le teorije virov kot osnove za raziskovanje rasti podjetij. Posledica tega priporočila je metodološka. Ker je poenostavljena formula $VIRI \Rightarrow RAST$ nezmožna pojasniti kompleksen proces rasti, morajo raziskovalci uporabiti (1) kvalitativne metode za bolj poglobljen vpogled v proces rasti in (2) pristope, ki temeljijo na teoriji kompleksnosti, da bodo lahko pojasnili procese rasti v populacijah podjetij. Kvalitativne metode omogočajo bogatejši vpogled, ki je nujen za raziskovanje procesa razvoja in rasti skozi čas. Lahko osvetlijo poglede rasti, ki jih je težko količinsko ovrednotiti. Alternativno lahko principi teorije kompleksnosti (kaotični sistemi, obdobja nespremenljivosti prekinjena z nenadnimi spremembami, pozitivne povratne zanke in odvisnost od poti) oživijo teorije rasti na podlagi faz življenjskega cikla, katerih razvoj se je ustavil zaradi nezadostne empirične podpore. Prvi korak k razlagam rasti, ki temeljijo na

kompleksnosti, bi lahko bila uporaba računalniških simulacij. Z njimi, še posebej z modeliranjem z agenti, bi lahko prišli do novih, boljših modelov rasti.

Definicija ovir za rast kot potrebnih pogojev za rast v tretjem poglavju ima tudi metodološke posledice. Tradicionalne statistične metode, ki temeljijo na korelacijskih povezavah (npr. multipla regresija) metodološko ne morejo zadovoljiti zahtev logike potrebnih pogojev. Temeljni problem s tradicionalnimi metodami je, da se naslanjajo na (linearno) seštevanje determinantnih spremenljivk (prediktorjev), s katerimi razlagamo rezultat (odvisno spremenljivko). Pomanjkanje ene determinante se lahko nadomesti s povečanjem drugih determinant v enačbi. To se ne ujema z logiko potrebnih pogojev, ki zahteva, da morajo biti vse determinantne spremenljivke neničelne, če želimo pozitiven rezultat (v našem primeru torej rast podjetja). Pomanjkanje ene spremenljivke torej ne moremo nadomestiti z drugimi. Metode, kot sta analiza potrebnih pogojev (NCA) (Dul, 2016) ali kvalitativna primerjalna analiza (Fiss, 2007; Schneider & Wagemann, 2012), so primernejše za empirično raziskovanje ovir za rast podjetij.

Praktične posledice

Proces in priporočila za izvedbo bibliometričnih analiz niso uporabna le za raziskovalce, ampak tudi za zaposlene v visokotehnoloških podjetjih, ki morajo prenesti znanstvena dognanja v razvoj novih izdelkov in storitev. Bibliometrične metode so uporabna orodja, ki omogočajo hiter pregled strukture raziskovalnega področja in lahko identificirajo najpomembnejše publikacije v njem. Poleg tega lahko identificirajo prihajajoče pomembne teme v literaturi (Ding & Chen, 2014). To pomeni, da se te metode lahko uporabijo v praksi za identifikacijo novega znanja, ki ima potencial za uporabo v izdelkih in storitvah.

Ocena teoretičnih temeljev raziskav o rasti podjetij je predvsem teoretične narave, a so nekatere posledice uporabne tudi v praksi. Stopnje rasti podjetij je izredno težko napovedati. Ker razlage na podlagi teorije virov niso dovolj za modeliranje rasti, morajo managerji upoštevati več kot samo vire podjetja, če želijo, da njihova podjetja rastejo. Verjamem, da je poslovni model, ki omogoča celovit pogled na samo podjetje, primernejši okvir za razmišljanje o rasti podjetja.

Model ovir za rast podjetij je uporaben za podjetnike, ki lahko v njegovem okviru strateško razmišljajo o dolgoročnem razvoju njihovega podjetja. Upoštevati morajo vseh pet ovir in sistematično odstranjevati ne le eno, ampak vseh pet, če želijo vztrajno rasti. Enako velja za snovalce vladnih politik za pomoč hitrorastočim podjetjem. Ti se navadno preveč osredotočajo le na eno od ovir – finance. Snovalci politik bi se morali bolj zavedati večnivojskih povezav med faktorji na nivoju podjetniškega ekosistema in ovirami za rast na nivoju podjetja. Nekateri dejavniki na nivoju ekosistema (npr. kultura) se spreminjajo izredno počasi in se nanje lahko vpliva le z doslednimi večletnimi ukrepi.

Smernice za prihodnje raziskave

Največji potencial za nadgradnjo bibliometričnih metod za pregledovanje znanstvene literature je v metodah, ki uporabljajo besedilo. Raziskave na področju strojnega učenja so v zadnjem času pomembno napredovale. Latentna Dirichletova alokacija (LDA) (Blei, 2012; Blei et al., 2003) je metoda, ki lahko identificira teme pogovora v velikih količinah tekstovnih podatkov, tako velikih, da jih človek ne more prebrati v sprejemljivem času. LDA so šele pred kratkim začeli uporabljati za analizo znanstvenih besedil (e.g. Jelveh, Kogut, & Naidu, 2014). Še posebej uspešna je lahko kombinacija metod, ki temeljijo na analizi teksta in metod, ki temeljijo na analizi sklicev. Vseeno bo potrebnih precej raziskav preden ugotovimo, kako uporabne in veljavne so te nove metode.

Za raziskave o rasti podjetij na splošno sem orisal pet možnosti za prihodnje raziskave. (1) Osredotočiti se je treba na vire, ki so vsestranski. Takšni viri imajo karakteristike, bolj uporabne za rast podjetja kot t. i. VRIN viri, ki so primerni za ustvarjanje konkurenčne prednosti in zagotavljanje profitabilnosti. (2) V prihodnje raziskave rasti podjetij je potrebno vključiti več perspektiv glede povpraševanja. Koncept poslovnega modela, ki vključuje tako vidik kreiranja vrednosti kot vidik zajema vrednosti, je morda za to najprimernejši. Tako lahko premosti disciplinarno razmejitev med strateškim podjetništvom in marketingom. (3) Več raziskav bi se moralo osredotočiti na proces rasti in ne samo na stopnje rasti. (4) Opustiti je treba poenostavljeno dojetje povezave med viri in rastjo in se osredotočiti na orkestracijo virov. (5) Več pozornosti bi bilo dobro nameniti posledicam rezultatov empiričnih raziskav za snovanje vladnih gospodarskih ukrepov za podporo hitrorastočim podjetjem.

Pri nadaljnjih raziskavah na področju ovir za rast podjetij, predlagam tri glavne smernice. Prvič, kvalitativne raziskave lahko globlje raziščejo mehanizme kako podjetniški ekosistemi vplivajo na ovire za rast. Kljub temu da sem definiral več večnivojskih povezav med faktorji na nivoju ekosistema in faktorji na nivoju podjetja, je to področje premalo raziskano. Drugič, večnivojske kvantitativne raziskave bi lahko uporabile metode, kot sta NCA in QCA, za določitev, v kolikšni meri vsaka od ovir omejuje rast. Tretjič, to teorijo sem razvil na primeru visokotehnoloških podjetij. Prihodnje raziskave morajo potrditi, v kolikšni meri je to definicijo ovir za rast možno generalizirati na druge tipe podjetij in druge kontekste.

Zaključek

Ta disertacija je moj doprinos k povečanju znanja o rasti visokotehnoloških podjetjih. Raziskovalci na področju managementa zdaj imajo enotno referenco za uporabo bibliometričnih metod pri pisanju preglednih člankov. Teoretične osnove rasti podjetij, ki so bile prej redko eksplicitno obravnavane, so zdaj precej bolj jasne. Model ovir pri rasti lahko služi podjetnikom kot okvir za razmišljanje o dolgoročni rasti in razvoju njihovega podjetja.

Snovalci gospodarskih ukrepov ga lahko uporabijo za načrtovanje holističnih politik s sistemskim pogledom in ne le partikularnih rešitev, ki ne bodo spodbudile rasti podjetij. Verjamem, da lahko model ovir pri rasti postane platforma za moj bodoči raziskovalni program. Delo se je šele dobro začelo!