

Essays on
Environmental Conditions and
Growth of Academic Spin-Offs

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There is the joy of mastery and understanding - not at all unique to scientific studies - the pleasure of seeing patterns emerging where none were seen before, the elegance of a fresh mathematical approach - all these treasures are there, and should not become invisible because of the shadows that the over-reach and over-application of **present** science and technology have cast.

Ursula Franklin

Acknowledgements

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In conclusion, I am extending a heartfelt thank you to my colleagues, clients, friends and family, who have offered support, distractions and acknowledgements.

Content

Synopsis	II
A. “The Environment for Academic Spin-Offs – The Case of Canada” <i>R. Sandra Schillo</i>	2
B. “Relationship Formation in Early-Stage Academic Spin-Offs: Exploring the Contributions of Founders and Technology Transfer Professionals” <i>R. Sandra Schillo and Achim Walter</i>	3
C. “Importance of Technological Evolution and Entrepreneurial Orientation for Academic Spin-Offs in Canada and Germany” <i>R. Sandra Schillo and Achim Walter</i>	4
D. “Can New Technology-Based Ventures Achieve Sales Growth through Open Innovation? An Empirical Study Accounting for Network Coordination Capabilities and Market Uncertainty” <i>R. Sandra Schillo and Achim Walter</i>	5

Synopsis

1 Overview of the Dissertation

The general topic of this dissertation is the role of the environment in the growth of spin-off companies from publicly funded research organizations. More specifically, it investigates the interaction of environmental factors and internal characteristics towards company performance. The general concept of environmental factors and their impact on growth is specifically integrated into the study in two ways: 1) through explicit operationalization as variable of interest, and 2) through the two-country design of the empirical research.

This cross-national design was rendered possible through the author's location in Canada, and the completion of this work as an external doctoral candidate under the guidance of Prof. Dr. Achim Walter, Chair in Entrepreneurship and Innovation Management. The work is presented in a series of academic articles. To set the stage for the empirical analyses, the first article outlines the operating environment for spin-offs in Germany and Canada, and subsequent articles empirically investigate specific dynamics and their impacts on company performance. Table 1 lists the articles. The contents and contributions of the articles are outlined in more detail in the following sections of this synopsis.

Table 1: Publications

Publications	Authors
A) The Environment for Academic Spin-Offs – The Case of Canada	R. Sandra Schillo
B) Relationship Formation in Early-Stage Academic Spin-Offs: Exploring the Contributions of Founders and Technology Transfer Professionals	R. Sandra Schillo and Achim Walter
C) Importance of Technological Evolution and Entrepreneurial Orientation for Academic Spin-Offs in Canada and Germany	R. Sandra Schillo and Achim Walter
D) Can New Technology-Based Ventures Achieve Sales Growth through Open Innovation? An Empirical Study Accounting for Network Coordination Capabilities and Market Uncertainty	R. Sandra Schillo and Achim Walter

2 Field of Investigation

Spin-off companies have by definition the potential to be a mechanism for the translation of research results into economic, environmental and/or social benefits. However, such impacts do not occur automatically; they typically require companies to survive and grow (Gilbert et al., 2006, p.926).

Despite considerable research on academic spin-offs, much remains to be learnt regarding how such growth occurs. In developing their model on small business growth, Wiklund et al. (2009, p.353) note that “a prominent stream of the existing literature suggests that the environment, in which a small business operates, has a major impact on its growth opportunities” (also see Autio, 2007). Research specifically on spin-off companies has explored the relationship between the external environment and spin-off growth much less, focusing instead on spin-off formation (Grandi and Grimaldi, 2005), characteristics of academic entrepreneurs (Zucker et al. 2002; Sarason et al., 2006), or managerial processes (Vohora, 2004).

Research on new, technology-based firms (NTBF), and on entrepreneurship in general, documents several dynamics between the external environment and company growth. As Bahadir et al. (2009 p.273) conclude in their meta-analysis drivers towards organic company growth that “the environment in which a firm operates both enables and constrains a firm's organic growth”. On the one hand, researchers have documented that the environment can provide NTBF with opportunities for growth (Shane and Venkataraman, 2000, p.175; Acs et al., 2009, p.17), and on the other hand, the environment can inhibit growth among those firms (Zahra and Bogner, 2000, pp.164-165; Wiklund et al., 2009, p.350).

Similar to research on spin-off formation, researchers on entrepreneurship have framed these dynamics in terms of a broad range of environmental factors affecting entrepreneurial opportunities and entrepreneurial capacity, which in turn affect new firm creation, resulting in jobs and technical innovation (Levie and Autio, 2007, p.238; Acs et al. 2005, p.14). Research on growth has typically framed the dynamics between environmental conditions and growth in terms of interactions of specific environmental variables with company characteristics. Among these studies the focus has often been on the environment's munificence, turbulence,

heterogeneity, hostility, dynamics, customer structure, competition, or uncertainty (Wiklund, 2009, p. 354; Covin and Covin, 1990; Sommer et al., 2009; Rauch et al., 2009). Authors of such studies suggest that the interactions between environmental variables and company characteristics are relevant and that future research should investigate the role of such moderators further (Rauch et al., 2009, p.781; Wiklund, 2009, p.367).

This present work aims to contribute to the exploration of the role of moderators, addressing specific gaps in the literature in separate articles, as described below. One notable feature of two of the three empirical studies is the two-country design, which allows to identify insights into the cross-national generalizability (van de Vijver and Leung, 1997, p.289-291) of the findings.

3 Topics of the Articles

To set the stage for the empirical studies, the first article provides a high-level overview of the environment for spin-offs in one of the two settings investigated in this study – Canada. Previous research has often considered the research-based spin-off as a university-industry boundary spanning mechanism, and has subsequently focused on the interaction between environmental factors and the university or research institution of origin (e.g. O’Shea et al. 2008, p.663). The work underlying this dissertation instead focuses on the growth of spin-offs once they are established.

While it is clear that “different entrepreneurial environments exist” for spin-offs (Clarysse et al., 2001), research to date has not systematically framed this environment from the perspective of spin-offs. The first article of this dissertation, titled “The Environment for Academic Spin-Offs – The Case of Canada”, addresses this gap and develops a framework that places the focal spin-off company at the centre. It identifies the key aspects of the spin-offs’ environment that can be expected to affect growth: the economy, geography and human resources, and the public research and development environment. The utility of this framework is demonstrated using data from Canada, one of the two focal countries in this work.

The empirical studies then consider the impact of specific aspects of a spin-off's environment on its growth in more detailed analyses. Much of the research considers the interplay of external factors with entrepreneurial orientation or networking aspects of the spin-offs. As noted by Wiklund et al. (2009, p.353), both the entrepreneurial orientation of a spin-off and its integration into external networks have been established in the literature as central to small business growth. While the interaction between entrepreneurial orientation and network competence has already been established as a significant contributor to spin-off growth (Walter et al., 2006, p.556), a range of contingencies relating to the spin-off's environment remained under-explored. Some of these are explored in the studies described below.

The first empirical article, "Relationship Formation in Early-Stage Academic Spin-Offs: Exploring the Contributions of Founders and Technology Transfer Professionals" explores how spin-offs initiate their interactions with the external environment. Research has documented the importance of relationships towards a company's ability to discover opportunities, secure resources, and obtain legitimacy (Elfring and Hulsink, 2003), while also documenting substantive risks and contingencies (Hoang and Antoncic, 2003). As a consequence, the relationship between companies' engagement with external partners and the influence on company performance is not entirely clear yet. Witt (2004, p.402) suggests that previous research has too narrowly focused on the entrepreneur with regards to a start-up's engagement in networks, and that a broader focus may increase understanding of relationship dynamics and their influence on start-up success. This study, like previous work by Siegel et al. (2007) and Audretsch et al. (2006), suggests that the ability of technology transfer professionals to contribute valuable relationships may be of particular interest in this context. It presents empirical evidence on the contributions of founders and technology transfer professionals in this process, and documents that there are notable differences based on the national environment (Germany or Canada) the spin-off operates in.

The second empirical article, "Importance of Technological Evolution and Entrepreneurial Orientation for Academic Spin-Offs in Canada and Germany" models an aspect of the spin-off's environment that academic founders can be expected to be particularly aware of due to their familiarity with the research environment: The pace of technological evolution. Research shows

that companies need to be aware of the technological evolutions in their field in order to benefit from market opportunities (Sood and Tellis, 2005). However, the effect of technological evolution in the spin-off's environment on company performance has not been investigated yet. This study addresses this gap and explores the interaction with entrepreneurial orientation, which has been shown to impact a company's ability to benefit from opportunities in its environment (Rauch et al., 2009). Again, differences between these interactions in Germany and Canada are noted.

Finally, the third empirical article, "Can New Technology-Based Ventures Achieve Sales Growth through Open Innovation? An Empirical Study Accounting for Network Coordination Capabilities and Market Uncertainty" places the spin-off in the increasingly important context of open innovation (Chesbrough et al., 2006). Previous research suggests that companies can increase their innovativeness by opening their innovation activities (Laursen and Salter, 2006; Leiponen and Helfat, 2010). However, empirical research has not yet documented the influence of open innovation on sales growth. This study addresses this gap and investigates whether spin-offs benefit from opening their innovation activities in terms of subsequent sales growth, and whether their ability to do so is influenced by the network coordination capabilities, and by uncertainty in their respective markets.

4 Data and Methodological Considerations

The first article in this dissertation consists of a review of economic, policy and management research. The remaining three articles present original empirical studies.

Two of the three empirical studies are based on a two-country study with quantitative data from Germany and Canada. Data were collected in personal interviews with founders / key executives of the spin-off companies. The structured interview guides were designed using processes of back-and forth translation and validation in pilot studies. In particular the Canadian data set is remarkable in that empirical studies of this scale, using in person interviews with companies

across Canada are relatively rare, likely due to the large geographic distances between cities and the resulting costs.

Given the goal of identifying impacts on company growth, the empirical studies employ regression analyses with sales growth as the dependent variable. Within the framework of regression analyses, a range of methodologies were employed on multiple data sets. The various latent factors were calculated and confirmed using SPSS, AMOS, Lisrel, and/or SmartPLS, depending on the requirements of each study. For the studies comparing the German and Canadian data sets, multi-group analyses were conducted, and measurement invariance was tested as required.

5 Major Contributions

The article on ‘The Environment for Academic Spin-Offs’ provides a new perspective on the components of a national innovation environment: It places the spin-off company at the centre of the economic, academic and societal forces that may influence its success. In doing so, it departs from analyses positioning spin-offs as a side-effect of university research (O’Shea et al., 2008, p.663). The article also applies the framework to describe the environment for Canadian spin-offs using extensive data sources.

The contribution of this piece lies in its potential to frame and facilitate policy discussions, the impact of which has already been demonstrated. For example, this work formed the basis for a contribution to a German-Canadian Workshop convening innovation policy developers from both countries (Schillo, 2008a). In turn, the workshop provided the basis for a contribution to the ACCT Conference in Ottawa, Canada (Schillo, 2008b). A poster presentation format was chosen to allow for in depth discussions with individuals attending the conference. This choice proved effective in allowing for additional discussions with Canadian policy makers and technology transfer practitioners, and international academics.

The remaining articles of this dissertation contribute to the development of the academic literature by testing theoretical advancement with original empirical data. The article on relationship formation extends previous research on the contributions of technology transfer

functions by moving the focal level of analysis from the technology transfer office to that of the professionals within the office. In prior research, only Audretsch et al. (2006) and Siegel et al. (2007) have pointed to the theoretical relevance of this approach, however these authors provided only scant empirical evidence. The empirical evidence presented in this study shows that contributions at the level of the technology transfer professionals, especially in terms of relationship formation, have positive impact on spin-off growth. Although this effect is only significant in Canada, the German sample does indicate that the direction of their contribution is positive, while the founders' contributions are significantly negative. These findings suggest that investigating the role of technology transfer professionals is a promising area for future research and they have managerial implications for relationship formation in early-stage spin-offs.

The article on the pace of technological evolution and entrepreneurial orientation in the two countries provides empirical evidence on a topic that has repeatedly been identified in prior research as worthy of additional study (Rauch et al., 2009, p.781; Wiklund, 2009, p.367): The interplay between company characteristics, such as entrepreneurial orientation, and environmental influences, in this case the pace of evolution in the spin-off's technology field. The study not only documents that such interactions exist, it also extends the previous work and suggests that the interactions also depend on the fit with the broader environment, as reflected in the two national settings. Indeed, the empirical analyses show that the interactions are significant in both contexts, but in opposite directions. These findings highlight the importance of cross-national comparisons for future research on spin-off companies, and they hold major policy and managerial implications for governments aiming to increase spin-off performance, investors seeking to maximize returns on spin-off investments, and managers seeking to establish their spin-off in their respective target markets.

The final article explores the interaction of spin-offs with their environment under the increasingly important framework of open innovation (Chesbrough, 2006). Its findings challenge the positive or curvilinear influences of openness documented in earlier studies (Laursen and Salter, 2006; Leiponen and Helfat, 2010), instead showing that the new spin-off companies investigated experience negative effects from openness. Network coordination capabilities – while generally beneficial to company growth – cannot help companies compensate for the

negative impact of openness. The study also makes contributions by extending current operationalizations of openness. In terms of the relevance of environmental aspects, the findings show that market uncertainty moderates the relationships between both network coordination capabilities and openness and company growth. Based on these findings, managers would be well advised to reinforce coordination capabilities, but to limit the openness of their innovation activities, especially under conditions of high market uncertainty.

While the primary contributions of the empirical work target academic audiences, the findings of the studies are also of policy and practical interest. Therefore, in addition to dissemination through academic channels, the conclusions from the empirical work have been communicated to individual policy developers and technology commercialization professionals within the Canadian government. Work to disseminate the findings will continue, as was promised to the study participants. Most likely, additional papers will be developed specifically for targeted audiences of practitioners and executives in policy development and technology commercialization.

6 Note on Co-Authorship

Several articles have been completed in collaboration between two authors. The order of co-authors reflects their respective contributions.

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ARTICLES

A. The Environment for Academic Spin-Offs – The Case of Canada

R. Sandra Schillo

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Abstract

Policy makers and academic entrepreneurs alike strive to successfully contribute to the growth of spin-off companies from publicly funded research. Research on spin-offs and on entrepreneurial companies in general shows that there are differences in the entrepreneurial environment across jurisdictions. This paper highlights the various drivers and barriers to growth in a spin-off's environment, first on a theoretical basis, and then at the example of Canada.

It specifically focuses on three aspects of particular importance to academic spin-offs: the economy, public research and development, and geography and people. In Canada, the environment is conducive to the formation of spin-offs, but there are a number of challenges associated with growing such companies.

B. Relationship Formation in Early-Stage Academic Spin-Offs: Exploring the Contributions of Founders and Technology Transfer Professionals

R. Sandra Schillo and Achim Walter

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ISBN 978-952-214-767-7.

Abstract

Research on spin-offs has so far centred on the contributions either by founders or technology transfer offices at the organizational level. As well, relationships with external stakeholders have often been posited as general beneficial to the development of the company. This study aims to develop more nuanced understanding of relationship formation in spin-offs. We provide empirical evidence from two countries, documenting the contributions of contacts with a range of stakeholder provided by individual Technology Transfer Professionals (TTPs) to sales growth. We find that founders should only take the lead in establishing initial contacts with external stakeholders if professional assistance is not available.

C. Importance of Technological Evolution and Entrepreneurial Orientation for Academic Spin-Offs in Canada and Germany

R. Sandra Schillo and Achim Walter

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Abstract

Entrepreneurial Orientation (EO) is widely recognized as related to company performance. However, the field of research has not yet developed comprehensive understanding of the complex moderating influences on this relationship. We investigate the EO -- performance relationship for research-based spin-offs, which are highly interconnected with their technological research and development environment. Using data from spin-offs in Canada and Germany, we find evidence for the EO - performance relationship of Canadian firms. Further analyses show that the pace of technological evolution moderates the EO -- performance relationship. Interestingly, it does so in different ways in each of the two countries in our study.

D. Can New Technology-Based Ventures Achieve Sales Growth through Open Innovation? An Empirical Study Accounting for Network Coordination Capabilities and Market Uncertainty

R. Sandra Schillo and Achim Walter

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Abstract

Companies are increasingly reaching beyond their internal capabilities in their innovation activities. This study investigates whether new technology-based ventures can expect to increase their performance by opening up their innovation processes, and whether the ability to do so is influenced by the company's network coordination capabilities or market uncertainty. The study uses a longitudinal design using multiple respondents to assess impacts on sales growth. The analysis of data from 85 young technology-based companies with academic founders suggests that openness has detrimental influence on sales growth. While network coordination activities have a positive effect on sales growth, they do not interact with openness and thus cannot alleviate the negative impacts of openness. Market uncertainty reinforces both the negative impact of openness and the positive impact of network coordination capabilities. These findings challenge the positive contribution of openness observed in a number of prior studies and provide guidance for future research.

Eidesstattliche Erklärung

Ich erkläre hiermit an Eides Statt, dass ich im Rahmen meiner Doktorarbeit „Essays on Environmental Conditions and Growth of Academic Spin-Offs“ die Einführung, sowie den Beitrag „The Environment for Academic Spin-Offs – The Case of Canada“ selbständig und ohne fremde Hilfe angefertigt habe, und weiterhin, dass ich als Koautor maßgeblich zu den Beiträgen „Relationship Formation in Early-Stage Academic Spin-Offs: Exploring the Contributions of Founders and Technology Transfer Professionals“, „Importance of Technological Evolution and Entrepreneurial Orientation for Academic Spin-Offs in Canada and Germany“, und „Can New Technology-Based Ventures Achieve Sales Growth through Open Innovation? An Empirical Study Accounting for Network Coordination Capabilities and Market Uncertainty“ beigetragen habe. Alle von anderen Autoren wörtlich übernommenen Stellen, wie auch die sich an die Gedanken anderer Autoren eng anlehnenen Ausführungen der aufgeführten Beiträge, wurden besonders gekennzeichnet und die Quellen nach den mir angegebenen Richtlinien zitiert.

Ottawa, 18. Juni 2010

Ruth Sandra Schillo