UNIVERSITEIT GENT

FACULTY OF **ECONOMICS AND BUSINESS ADMINISTRATION**

Antecedents and performance implications of new ventures' business model development processes in the mobile health industry

LIEN DENOO

2015

ADVISOR:

BART CLARYSSE

Submitted at Ghent University Faculty of Economics and Business Administration in partial fulfillment of the requirements for the Degree of Doctor of Applied Economics

PhD Series – Ghent University 2015

Faculty of Economics & Business Administration

Lien Denoo her work on this dissertation was sponsored by
the Intercollegiate Center for Management Science (I.C.M.).

ADVISOR

Prof. dr. Bart Clarysse, Ghent University

GUIDANCE COMMITTEE

Prof. dr. Bart Clarysse, Ghent University

Prof. dr. Johan Bruneel, KU Leuven

Prof. dr. Helena Yli-Renko, University of Southern California, USA

READING COMMITTEE

Prof. dr. Petra Andries, Ghent University

Prof. dr. Annelies Bobelyn, Eindhoven University of Technology, the Netherlands

Prof. dr. Johan Bruneel, KU Leuven

EXAMINATION COMMITTEE

Prof. dr. Marc De Clercq, Ghent University (Dean & President)

Prof. dr. Patrick Van Kenhove, Ghent University (Academic secretary)

Prof. dr. Bart Clarysse, Ghent University

Prof. dr. Johan Bruneel, KU Leuven

Prof. dr. Helena Yli-Renko, University of Southern California, USA

Prof. dr. Petra Andries, Ghent University

Prof. dr. Annelies Bobelyn, Eindhoven University of Technology, the Netherlands

Prof. dr. Mike Wright, Imperial College London, UK & Ghent University, Belgium

Acknowledgements

Good company in a journey makes the way seem shorter.

Izaak Walton

Even though at times the PhD journey felt as if it had no endpoint, the journey would have been a lot longer and harder to undertake without the company that contributed to this PhD in numerous ways along the way.

The PhD journey started with Prof. Bart Clarysse agreeing to take me on as his PhD student. I would like to thank Bart for giving me this exciting opportunity and for providing funding during the first years of my PhD. I also greatly appreciate the opportunities and freedom he has given me during the PhD process, the research projects he has included me in, and the people he has introduced me to during the past few years. Finally, I would like to thank him for his input on my dissertation and other research projects, and for the many ideas he has given me over the years that has helped me shape my research.

The second person that I would like to thank is Prof. Helena Yli-Renko. Helena, I really appreciate that you agreed to take me in as a visiting scholar at the Lloyd Greif Center and that you gave me the opportunity to spend two years, and now more beyond the doctorate, living and working in Los Angeles. I would also like to thank you for all the advice that you have given me on my dissertation and career choices, the research lunch meetings we have had at your house, introducing me to many great scholars at USC, the support you have given me while I was writing my dissertation, and also having agreed to be a part of my doctoral guidance and examination committee.

My deep gratitude also goes out to Prof. Johan Bruneel, who also agreed to be part of both my doctoral guidance committee and the reading and examination committee. Johan, you have given me so much great advice when we were both still working in Ghent, advice that I still remember and use in my research. I would also like to thank you for the important role you played in my move to Los Angeles; you always managed to put me at ease when I was worried about moving to a city almost 9000 kilometers away.

I would also like to thank the other members of the doctoral examination committee, beginning with Prof. Annelies Bobelyn. Annelies, you were the very first one to give me job tasks when I started as a PhD student and I have always looked up to your knowledge and experience when you were the senior PhD student in the department. Having you as a member of my reading and examination committee and getting your advice on my dissertation meant a lot. Thank you.

Prof. Petra Andries, we may not have met each other frequently, but as I spent hours and hours coding business models of nearly 200 firms using your business model scale, I feel like I know you that much better. I appreciate the time you took for reading and examining my dissertation and the great feedback you have provided me.

Prof. Mike Wright, I would like to thank you for finding the time in your busy schedule to read my dissertation and to participate in the internal defense. Thank you for always being available when I needed something, ranging from a recommendation letter to being part of my examination committee.

Finally, I would like to thank Prof. Marc De Clercq and Prof. Patrick Van Kenhove for taking part in the official closure of my doctoral journey.

I would also like to thank everyone that was involved in taking care of the administrative aspect of finalizing this dissertation. Wieland De Caluwe and Anneke Van den Sompel, I appreciate the time you took to reply to the numerous e-mails I sent you. Ann De Smaele and Sofie De Clerck, I appreciate the help you gave me in meeting all deadlines and submitting documents in person that I could not take care of by myself, being located in Los Angeles. I also appreciate your help with all other administrative processes and questions that I have had during the past few years.

I would also like to acknowledge the financial support from the Intercollegiate Center for Management Science, without which this dissertation and my research stay in Los Angeles would not have been possible. Françoise Charlez and Dirk Symoens, thank you for taking care of all the administrative aspects of being an ICM scholar.

Next in line are all the great colleagues I have had at Ghent University over the years. Anneleen and Charlotte, I would like to thank you for the endless e-mails with support and advice we have exchanged over the last couple of months when we were finalizing our PhD's together. Anneleen, I also fondly remember your two visits to Los Angeles, as well as some of the conference experiences we shared in Texas. Charlotte, we started and finished our PhD's at virtually the same time, applied for scholarships together, got stuck in union actions together, and my PhD experience would have been a lot different without you. Jolien and Robin, I could not have asked for better office mates when I was still in Ghent. Jolien, we had good times jointly making fun of Robin. Robin, you were always in for a joke or for a "throw a piece of paper in the trash can" competition. Thanks for that. I would also like to thank some of the other PhD students that were at our

department, Inge, Aarti, Jonas, for being great colleagues. I would also like to acknowledge some of the more senior colleagues of the department: Bart L., Mirjam and Iris, you were always willing to help and to share some of your experiences with me; thank you.

I would further like to thank everyone at the Greif Center at USC for helping create a hospitable and nice environment for me to arrive in, and Jackie Yu in particular for taking care of extending my visas and all other administrative problems that I have encountered. My deep gratitude also goes to Prof. Peer Fiss for allowing me to audit his course, introducing me to fsQCA and for always being willing to help me and give me great advice. I would further also like to acknowledge Prof. Nandini Rajagopalan for her help and advice. A big thank you also goes out to Medha Raj and Kristen Guth for being fellow PhD students, giving advice and support, helping me with my dissertation, and for being good friends in general.

I would also like to thank the two student workers that were instrumental in the data collection process of this dissertation. Jacob Clarysse and Sukhun Kang, this dissertation would not have been possible without your help. Thank you.

Next in line are my friends. I really appreciate the support and friendship you have given me over the years, even when I decided to move to LA. I would especially like to thank everyone that came out and visited me in LA: Sarah, Elise, Annelies and Lieselot. While in LA, I also met a lot of great people without whom the experience of living there would have been a lot different. Alison, Miel, Linda, Damien and Bart V., life in LA would have been a lot less fun without all of you.

Last but not least, I would like to thank my family: Ruben and Josephine, Lisa, Mom and Dad. Even if you were not the biggest fans of me doing a PhD and certainly not of me moving to Los Angeles, you nevertheless supported me in all my choices and sent me many care packages from Belgium. Ruben and Josephine, I am looking forward to seeing you in LA next year. Lisa, if you read this dissertation, maybe you will finally believe that PhD students actually also do other things than merely copying and pasting numbers in Excel. Mom and Dad, thanks for supporting me throughout my PhD, listening to my complaints of having to write a dissertation, and just generally for being there for me.

Lien Denoo

Los Angeles, September 2015

Table of Contents

Acknowledgements vii
SAMENVATTING xxiii
SUMMARY xxvii
LIST OF PUBLICATIONS AND CONFERENCE PRESENTATIONS BASED ON THIS DISSERTATION xxxi
1. INTRODUCTION 1
1.1. Background 3
1.2. Research gaps and questions 6
1.3. Research context and methodology 9
1.4. Objectives and expected contributions of dissertation 11
1.5. Dissertation outline 13
1.6. References 15
2. REVIEW OF THE BUSINESS MODEL LITERATURE 17
2.1 Methodology 19
2.2 Positioning compared to previous review paper 21
2.3 Overview of business model literature: research themes 23
2.3.1 What are business models and what do they do? 23
2.3.2 Studies on business models for specific industries or settings 25
2.3.3 Impact of business models on performance 27
2.3.4 Business model innovation: studies on how to build innovative business models . 34
2.3.5 Adoption of innovative business models by incumbents, replicators and new entrants 35
2.3.6 Business model change processes 37
2.3.7 Studies with a related topic, but with only a marginal focus on business models .. 38
2.4 Overview of business model literature: empirical perspective 39
2.4.1 Qualitative studies 39
2.4.2 Quantitative studies 40
2.4.3 Mathematical modelling 41
2.5 Gaps in research on business models 44
2.5.1 Research themes 44
2.5.2 Empirical perspective 48

2.5.3 Combining the research theme and empirical gaps in the business model literature 49
2.6 Conclusion 51
2.7 References 53
3. RESEARCH SETTING & METHODOLOGY 57
3.1 What is mobile health or mHealth? 59
3.2 The emergence of the mobile health industry 60
3.2.1 Mobile internet 60
3.2.2 Smartphones 61
3.2.3 Rising healthcare costs 62
3.3 Overview of players in the mHealth industry 63
3.4 Types of mHealth organizations 71
3.5 Why the mHealth industry? 72
3.6 Population and sample 75
3.7 Data collection methodology 79
3.8 Operationalization of the constructs 81
3.8.1 Business model constructs 81
3.8.2 Alliance constructs 84
3.8.3 Time-fixed company-level constructs 85
3.8.4 Time-varying company-level constructs 86
3.8.5 Time controls 88
3.9 Descriptive statistics of the sample 88
3.9.1 Age of sample firms 89
3.9.2 Industry segments of sample firms 89
3.9.3 Location of sample firms 90
3.9.4 Company status of firms 91
3.9.5 Business model changes of sample firms 91
3.9.6 Alliances of sample firms 94
3.10 Statistical methods 95
3.10.1 Multiple linear regression 95
3.10.2 Moderation/Interaction 97
3.10.3 Heckman selection model 98
3.10.4 Survival analysis 99

3.10.5 Robust (Hubert/White - sandwich) standard errors 100
3.11 References 102
4. HOW ALLIANCES AND EXPERIMENTATION INFLUENCE BUSINESS MODEL CHANGES IN NEW VENTURES 105
4.1 Theory and Hypotheses Development 111
3.2.1 Business model experimentation 111
3.2.2 Alliances as drivers of business model change 113
3.2.3 Interaction effect of business model experimentation and alliances on business model change 118
4.2 Methods 120
4.2.1 Sample and data 120
3.2.4 Measurement: Dependent Variables 120
3.2.5 Measurement: Explanatory Variables 121
3.2.6 Measurement: Control variables 122
3.2.7 Model specification and estimation 125
4.3 Results 126
3.3.1 First-stage Business Model Change Likelihood Estimates 129
3.3.2 Heckman selection model 131
3.3.3 Second-stage Degree of Business Model Change Estimates 131
4.4 Discussion 134
4.5 Contributions 136
4.6 Implications for practitioners 137
4.7 Limitations and future research avenues 138
4.8 Conclusion 140
4.9 References 141
5. THE IMPACT OF BUSINESS MODEL CHANGE PROCESSES ON THE PERFORMANCE OF NEW VENTURES IN EMERGING INDUSTRIES 145
5.1 Theory and Hypotheses Development 150
4.1.1 Impact of business model change on performance 151
4.1.2 Impact of degree of business model change on performance 154
4.1.3 Impact of time since last business model change on performance 157
4.1.4 Interaction between degree of business model change and time since last business model change on performance 160

5.2 Methodology 163
4.2.1 Sample and data 163
4.2.2 Measurement: Dependent variables 163
4.2.3 Measurement: Independent variables 165
4.2.4 Measurement: Control variables 167
4.2.5 Model specification and estimation 171
5.3 Results 172
5.3.1 First-stage estimates: Impact of having changed business model on performance 175
5.3.2 Heckman selection model 176
5.3.3 Second-stage estimates: Impact of business model change processes on performance 178
5.4 Discussion 184
5.4.1 Implications for organizational change literature 184
5.4.2 Implications for entrepreneurship literature 187
5.4.3 Implications for business model literature 188
5.5 Implications for practitioners 189
5.6 Limitations and future research implications 190
5.7 References 193
6. CONCLUSIONS, CONTRIBUTIONS AND FUTURE RESEARCH AVENUES 197
6.1 Introduction 199
6.2 Main findings and contributions 200
6.3 Academic contributions 205
6.3.1 Implications for the business model literature 205
6.3.2 Implications for the organizational change literature 206
6.3.3 Implications for the organizational learning literature 208
6.3.4 Implications for the alliance literature 208
6.3.5 Implications for effectuation literature 209
6.3.6 Implications for the entrepreneurship literature 210
6.4 Practical implications 210
6.4.1 Implications for entrepreneurs 211
6.4.2 Implications for venture capitalists and other financiers 212
6.4.3 Implications for incubators and accelerators 212

6.4.4 Implications for policy makers 213
6.5 Limitations and avenues for future research 213
6.5.1 Sample 213
6.5.2 Variables 215
6.5.3 Method of analysis 217
6.6 Conclusion 218
6.7 References 219
APPENDICES 221
APPENDIX A – BUSINESS MODEL CATEGORIZATION SCHEME 223
APPENDIX B – AVERAGE DEVIATION INDEX AS MEASURE OF INTER-RATER AGREEMENT 225

List of Figures

Figure 1.1 – Overview of general and specific research questions in dissertation 7
Figure 2.1 – Overview of articles included in this study per year 21
Figure 2.2 – Overview of gaps in business model research 51
Figure 3.1 – Overview of players in the mobile health industry 64
Figure 3.2 – Overview of initial and final sample size. The line should be read on the left axis and the bars on the axis on the right. 79
Figure 3.3 - Distribution of total number of alliances held by sample firms 94
Figure 3.4 - Percentual breakdown of alliances per type 95
Figure 4.1 – Conceptual framework 120
Figure 4.2 – Interaction effect between business model experimentation and number of new alliances 133
Figure 5.1 – Overview of hypotheses in this study 163
Figure 5.2 – Two-way interaction effect between degree of business model change and time since last business model change 181

List of Tables

Table 2.1 – Overview of articles per journal 21
Table 2.2 – Overview of business model literature: theoretical perspective 28
Table 2.3 - Overview of business model literature: empirical perspective..... 42
Table 3.1 – Age of sample firms..... 89
Table 3.2 – Industry segments of sample firms 90
Table 3.3 - Location of sample firms..... 90
Table 3.4 - Overview of company status of sample firms 91
Table 3.5 - Overview of number of firms that changed their business models 91
Table 3.6 - Overview of number of business model changes per company 92
Table 3.7 - Overview of frequency of changes per business model item and component 93
Table 4.1 – Descriptive statistics and correlation tables..... 128
Table 4.2 – Probit Estimates for Heckman First-Stage Model: Likelihood of Engaging in Business Model Change..... 130
Table 4.3 – Estimates for Heckman Second-stage Model 132
Table 5.1 – Descriptive statistics and correlation tables..... 173
Table 5.2 – Regression estimates for first-step model (hypothesis 1) 177
Table 5.3 – Probit estimates for Heckman selection model..... 178
Table 5.4 – Second-step regression estimates for impact of BM change on new product development..... 180
Table 5.5 – Second-step regression estimates for survival analyses with “ceasing to exit as independent venture” and “likelihood of being acquired” as dependent variables 182
Table 5.6 – Overview of supported hypotheses per dependent variable 183

SAMENVATTING

Het vinden van een geschikt businessmodel is een van de belangrijkste vereisten voor een bedrijf om succesvol te worden of blijven. Een businessmodel omvat namelijk zowel de inputs, zoals kennis en middelen, waar een bedrijf toegang toe heeft, alsook de verwerking van deze inputs tot economische outputs. Dit doet het bedrijf door zich te richten op bepaalde markten waar het uiteindelijk hoopt klanten te vinden. Een bedrijf dient een doordachte keuze te maken op elk van deze vlakken om zo een coherent businessmodel te vinden, dat aangepast is aan de doelgroep van het bedrijf, en tegelijk ook rekening houdt met de omgeving waarin een bedrijf zich bevindt en met de partners waar een bedrijf mee samenwerkt of wil mee samenwerken.

Vaak wordt aangenomen dat succesvolle bedrijven zoals Google en Symantec meteen het geschikte businessmodel gevonden hebben, namelijk het businessmodel waarmee deze bedrijven bekend geworden zijn. Nochtans zijn ook deze bedrijven oorspronkelijk gestart met een ander businessmodel. Het ontwikkelen van en experimenteren met verschillende businessmodellen is dus belangrijk voor nieuwe bedrijven. Nieuwe bedrijven zijn vaak ook actief in ontluikende industrieën. Dit zijn industrieën waar er nog geen dominant businessmodel is, en waar het nog niet duidelijk is wie de klanten zijn, en op welke manier bedrijven waarde zullen kunnen creëren. In deze industrieën is het experimenteren met verschillende businessmodellen dus nog belangrijker, aangezien het nog voor niemand duidelijk is hoe succesvol waarde gecreëerd kan worden.

Ondanks de belangrijke impact van een businessmodel en de ontwikkeling ervan op het uiteindelijke succes van een bedrijf, is er slechts weinig onderzoek dat zich hierop gefocust heeft. Daarom wordt in deze doctoraatsthesis nagegaan wat de oorzaken en gevolgen zijn van businessmodel ontwikkeling bij jonge bedrijven in een ontluikende industrie.

Na een eerste, inleidend hoofdstuk, wordt in het tweede hoofdstuk van deze doctoraatsthesis dieper ingegaan op de reeds bestaande academische literatuur over businessmodellen. Met behulp van een literatuuroverzicht wordt een beeld geschetst van de bestaande literatuur over businessmodellen, alsook waar nog ruimte bestaat voor verder onderzoek. Dit overzicht wordt tevens ook gebruikt om de twee empirische studies van deze thesis te positioneren.

In het derde hoofdstuk wordt een overzicht gegeven van de ontluikende industrie die als setting gebruikt wordt voor deze doctoraatsthesis. Deze industrie is de mobile health (i.e. mobiele gezondheids-) industrie, waarin gezondheidsgerelateerde toepassingen voor smartphones gemaakt worden, die als doel hebben mensen gezonder te maken en bepaalde administratieve processen die te maken hebben met de gezondheidssector te vereenvoudigen. Tevens wordt in dit hoofdstuk een overzicht gegeven van hoe de steekproef van bedrijven die in deze thesis gebruikt wordt, geïdentificeerd werd. Verder wordt er ook vermeld hoe de nodige data voor de twee empirische studies van deze thesis gecollecteerd werd.

In hoofdstuk vier werd de eerste empirische studie van dit doctoraat besproken, die als doel heeft om na te gaan hoe experimenteren en allianties een invloed kunnen hebben op de businessmodel ontwikkeling van bedrijven. De resultaten tonen dat experimenteren ertoe leidt dat bedrijven minder radicale veranderingen aanbrengen in hun businessmodel, en dat het aantal nieuwe allianties van bedrijven een rol speelt in het voorspellen van welke bedrijven hun businessmodel wel zullen veranderen, en welke niet.

Hoofdstuk vijf bevat de tweede empirische studie van dit doctoraat. In deze studie wordt nagegaan hoe de businessmodel ontwikkelingsprocessen van bedrijven een impact hebben op hun succes als bedrijf. Als indicatoren voor succes worden drie verschillende indicatoren gebruikt: nieuwe productontwikkeling, waarschijnlijkheid om als onafhankelijk bedrijf te blijven voortbestaan, en

de waarschijnlijkheid om als bedrijf overgenomen te worden. De resultaten tonen dat bepaalde businessmodel veranderingsprocessen, zoals de mate waarin het businessmodel veranderd wordt, een negatieve korte termijn impact kunnen hebben. Op langere termijn hebben deze veranderingsprocessen echter geen negatieve impact op de drie verschillende succesindicatoren, en businessmodel verandering heeft zelfs een positieve impact op de ontwikkeling van nieuwe producten van een bedrijf.

In het zesde en laatste hoofdstuk worden de belangrijkste bevindingen en conclusies van deze doctoraatsthesis samengevat. Bovendien wordt er aangegeven op welke manier deze bevindingen bijdragen tot verschillende academische literatuurstromen, alsook welke implicaties deze bevindingen hebben voor ondernemers, risicokapitaalverschaffers, en de overheid. Het hoofdstuk wordt afgesloten met enkele methodologische beperkingen en met suggesties voor verder onderzoek rond businessmodellen.

SUMMARY

Having the right business model is one of the most important requirements for a firm to become or remain successful. A business model does not only include the inputs that a firm has access to, such as knowledge and resources, but also the economic outputs a firm produces. By targeting a specific market, the firm hopes to find customers that can help generate these economic outputs for the firm. A firm needs to make choices on all these components in order to find a coherent business model, tailored to the firm's target market, and that also takes into account the environment in which the firm is present and the set of partners with which the firm collaborates or hopes to collaborate.

A common misconception is that successful firms such as Google and Symantec immediately found the right business model, i.e. the business model that made them famous. By contrast, these firms also started with a different business model. Developing and experimenting with business models is thus important for new ventures. Moreover, new ventures are often present in emerging industries, that is, industries in which there is no dominant business model yet, where it is still unclear who the customers will be, and how firms can create value. Experimenting with different business models is thus even more important in such industries, as it is not yet clear to anyone how value can be created and who will become successful.

Despite the importance of business model experimentation and the impact it can have on a firm's performance, few scholars have focused on this specific topic. As such, in this doctoral dissertation, I investigate what the causes and consequences are of new ventures' business model development processes in an emerging industry.

The first chapter of this dissertation is an introductory chapter, followed by a chapter that summarizes the existing business model literature. This second chapter contains a literature review that is used to identify the main research topics in the business model literature, as well as some remaining gaps in this literature. The literature review in this chapter is also used to more clearly position the two empirical chapters of this dissertation within the broader business model literature.

The third chapter describes the emerging industry that is used as the empirical setting for this dissertation, i.e. the mobile health or mHealth industry. Mobile health is an industry in which health-related applications are made for smartphones and mobile devices, such as tablets. These applications typically aim to improve the health and fitness of their users, or to simplify administrative processes between several health-related professionals, such as doctors and hospitals. In this chapter, I also further describe the sample selection and data collection techniques that are being used in this dissertation.

The fourth chapter contains the first empirical study of this dissertation. In this study, I investigate how experimentation and alliance formation can influence both the likelihood and degree of business model change of new ventures in the mobile health industry. The results show that experimentation leads to less radical business model change, while the formation of new alliances by new ventures plays a role in predicting which firms will change their business models, and which firms will not.

Chapter five comprises the second empirical study of this dissertation, in which I analyze how the business model change processes of new ventures can have an impact on their performance. Performance is measured with three different indicators: new product development, likelihood of surviving as independent venture, and likelihood of being acquired. I find that some business model change processes, such as the degree of business model change, can have a negative short-

term impact on performance, but that no business model change processes have a longer-term negative impact on any of the three performance indicators. Conversely, the results show that business model development even has a positive impact on the new product development efforts of a firm.

In the sixth and final chapter of this dissertation, I summarize the main findings and conclusions. Moreover, I describe how the conclusions of this dissertation contribute to various academic literature streams, as well as the practical implications these conclusions have to offer to entrepreneurs, investors and public policy. I end this chapter by listing some methodological limitations of this dissertation, as well as by offering avenues for future research.

LIST OF PUBLICATIONS AND CONFERENCE PRESENTATIONS BASED ON THIS DISSERTATION

WORKING PAPERS

Denoo, L., Yli-Renko, H., & Clarysse, B. 2015. How Alliances and Experimentation Influence Business Model Changes in New Ventures.

Denoo, L., Yli-Renko, H., & Clarysse, B. 2015. The Impact of Business Model Change Processes on the Performance of New Ventures in Emerging Industries.

CONFERENCE PRESENTATIONS

Denoo, L., Yli-Renko, H., & Clarysse, B. 2014. The More the Merrier? How Additions to New Ventures' Alliance Portfolios Affect Business Model Change. Babson College Entrepreneurship Research Conference, London, Ontario, Canada.

Denoo, L., Yli-Renko, H., & Clarysse, B. 2015. The Impact of Business Model Change on New Ventures' Survival. Babson College Entrepreneurship Research Conference, Wellesley, MA.

Denoo, L. & Yli-Renko, H. 2015. How Alliances and Experimentation Influence Business Model Changes in New Ventures. Academy of Management Annual Meeting, Vancouver, BC, Canada.

Denoo, L. & Yli-Renko, H. 2015. The Antecedents of New Ventures' Business Model Changes in an Emerging Industry. Strategic Management Society Annual conference, Denver, CO.

1. INTRODUCTION

1. INTRODUCTION

"πάντα χωρεῖ καὶ οὐδὲν μένει" - *Everything changes and nothing stands still.*

Heraclitus (535 BC-475 BC)

"An emerging dynamic perspective sees business model development as an initial experiment followed by constant revision, adaptation and fine tuning based on trial-and-error learning."

Sosna, Trevinyo-Rodriguez & Velamuri (2010)

1.1. Background

When thinking of some of the world's most famous companies, we often assume that they always executed the same activities, pursued the same target markets, and offered the same products. This is not the case, however. Google, for example, began as a library reference search tool and subsequently morphed into an OEM Internet search product before finally discovering its most successful product, AdSense (Furr, Cavarretta, & Garg, 2012; Vise & Malseed, 2006). Similarly, Symantec started out as an artificial intelligence company, changed into a linguistics platform and later morphed into an antivirus software company (Dorf & Byers, 2008; Furr et al., 2012). Some less known examples include Terracycle and TigerText. Terracycle started out by commercializing worm excrement, subsequently morphed into a company selling organic fertilizers and finally launched a successful waste management program (Lepoutre, Read, & Margery, 2012). TigerText's change was more subtle, as it only changed its target market, while offering the same product. The company started out by offering a secure messaging app that was inspired by a well-known professional sports player's adultery, and was thus targeted at individual users, before

becoming more successful by offering their product to the medical sector, in which secure messaging and data transfer is also important.

What all these companies have in common is that they undertook several changes before finding their most successful business model. Contrary to popular belief, firms thus do not immediately start up with the perfect business model that will make them successful. It is precisely this topic of changing one's business model that is the topic of this dissertation. Before digging deeper into the importance of business model change, I will start out with defining and clarifying what exactly a business model is.

There are numerous definitions of a business model, but the definition used in this dissertation is the one by Chesbrough and Rosenbloom (2002, p. 532), who define it as "a coherent framework that takes technological characteristics and potentials as inputs and converts them through customers and markets into economic outputs". The six main components that, in this dissertation, are seen as jointly constituting a business model are (1) how the firm creates or plans to create value, (2) who the firm creates value for, (3) what the firm's source of competence is, (4) how the firm competitively positions itself, (5) how the firm makes money and (6) what the time, scope and size of the firm's ambitions are (Morris, Schindehutte, & Allen, 2005). Changes in any of these six main components are thus considered as a business model change in this dissertation.

As shown in the four examples above, business model changes can be important mechanisms to ensure firm success. While previous studies have supported the view that business model change is important (e.g. Andries, Debackere, & Van Looy, 2013; Sosna, Trevinyo-Rodriguez, & Velamuri, 2010), most studies of business model change focus on established ventures' responses to the introduction of new business models into an industry by new entrants (e.g. Casadesus-Masanell & Llanes, 2011; Casadesus-Masanell & Zhu, 2010; Kim & Min, 2015). Some scholars,

however, have argued that business model change and experimentation processes with business models are particularly important for new ventures. Andries et al. (2013), for example, argue that entrepreneurial ventures should experiment with a range of business models. Blank (2013) even goes a step further by defining a start-up as a "temporary organization designed to search for a repeatable and scalable business model" (Blank, 2013, p. 5), thereby suggesting that a start-up's primary goal should be business model experimentation. Despite the consensus there seems to be on the importance of business model changes for new ventures, few studies have focused on what new ventures' business model change processes look like, what drives them, and what the performance implications of these change processes are.

Another contingency in which business model change has been argued to be important, is the context of an emerging industry. An emerging industry is an industry in which there is no dominant design, where the customers are unclear, the product attributes undefined and the industry value chain poorly established (Santos & Eisenhardt, 2009). Changes in these components due to the evolution and growth of the industry are bound to have an impact on a firm's business model, as a firm's business model should reflect both the target customers, the product attributes it will offer, and the way in which it will cooperate with its partners (Amit & Zott, 2001; Chesbrough & Rosenbloom, 2002). The importance of business model change in the setting of an emerging industry was also hinted at by Teece (2010), who stated that "[t]he right business model is rarely apparent early on in emerging industries" (Teece, 2010, p. 187), thereby suggesting that firms in emerging industries will have to change their business models before finding the right one. The setting of an emerging industry thus lends itself to research on business model change, as the uncertainties and development of the industry will make business model change more likely than in established industries.

In this dissertation, I will combine the two contingencies of new ventures and emerging industries and will investigate what drives business model change in new ventures in an emerging industry, as well as how these business model change processes impact their performance. I will describe the specific research questions of this dissertation and the gaps in the literature they address in the next section.

1.2. Research gaps and questions

In the previous section, I mentioned that this dissertation will focus on the contingency of business model change by new ventures in an emerging industry. This setting was not chosen ad hoc, but was determined by a review of the business model literature. By executing such a review of the business model literature, I was able to identify that most studies focused on established ventures or did not distinguish between new and established ventures, and that most studies focusing on an emerging industry investigated incumbents' responses to new entrants in the industry. These studies mostly ignored how new ventures and firms in emerging industries face additional challenges when compared to more established firms or firms active in more established industries, and how these challenges will make business model change both more likely and more necessary to survive, which is why I focus on this contingency in this dissertation.

Based on this literature review, I formulated a general research question for this dissertation, which is: *What are the causes and consequences of new ventures' business model change processes in an emerging industry?*

This more general research question was then split up into two separate research questions, that each have been addressed in a separate empirical study in this dissertation. Figure 1.1 below visually represents the general and the two more detailed research questions.

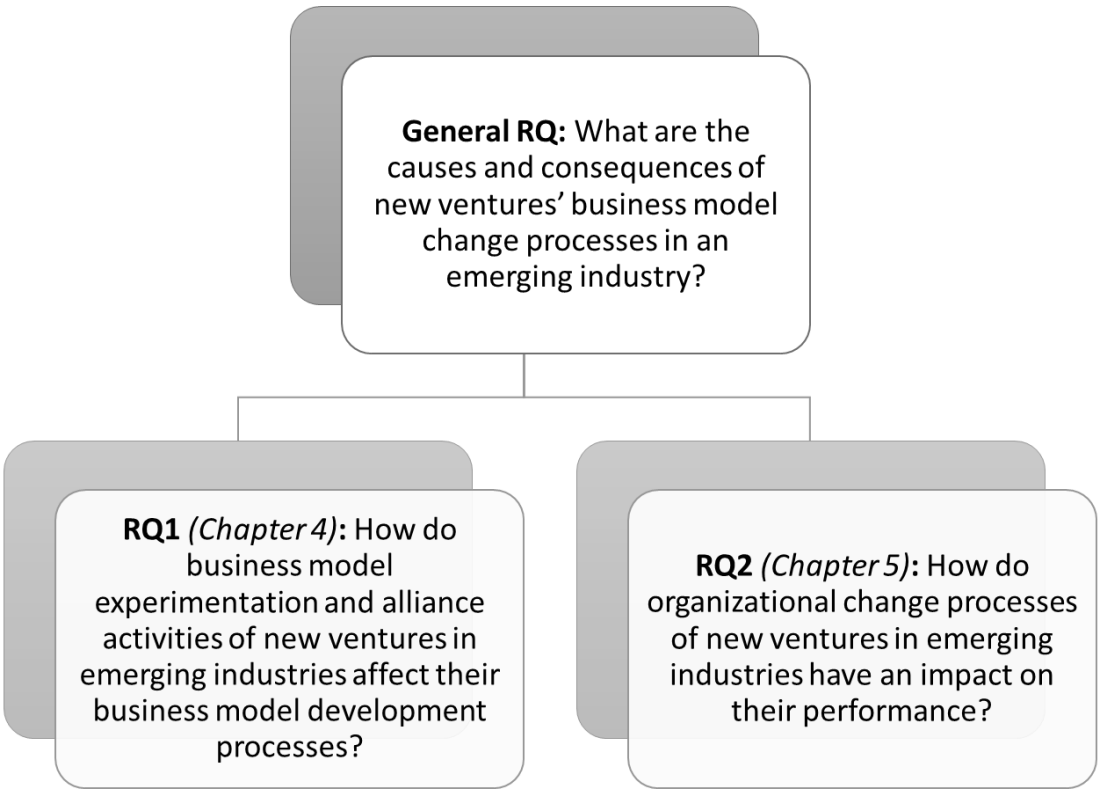


Figure 1.1 – Overview of general and specific research questions in dissertation

The first of these empirical studies addresses the research question: *How do business model experimentation and alliance activities of new ventures in emerging industries affect their business model development processes?*

This research question was not only inspired by the lack of research on new ventures in emerging industries, as was mentioned before, but also by two other gaps in the business model literature that became apparent in the literature review. These gaps are the lack of research on business model change, and a lack of holistic research on business models, that takes into account the ecosystem in which a firm is present and the alliance partners that a firm has established and collaborates with.

In response to these gaps, this study examines the drivers of new ventures' business model change. Along with my co-authors, I investigate how a firm's previous business model experimentation and the new alliances that a firm establishes can influence a firm's business model change. Business model change is measured as the likelihood of changing one's business model, as well as the degree to which a firm changed its business model. We use a longitudinal dataset of new ventures in the mobile health industry to test our hypotheses, which predict that both business model experimentation and new alliances will make subsequent business model change more likely. Moreover, we hypothesize that for firms that changed their business models, business model experimentation would lead to less radical business model change and new alliances to more radical business model change. Finally, we argue that new alliances will significantly mitigate the negative effect of business model experimentation on the degree of business model change. This study makes contributions to the business model and alliance literatures and draws on experiential and interorganizational learning theory, effectuation, and the literature on business ecosystems.

The second empirical study focuses on the consequences of business model change, by addressing the following research question: *How do organizational change processes of new ventures in emerging industries have an impact on their performance?*

This research question was again inspired by the lack of business model research on new ventures, ventures active in emerging industries and on the concept of business model change. In this second empirical study for which I again worked with two co-authors, I investigate the impact of new ventures' organizational change processes, conceptualized as their business model change processes, on their performance. New venture performance is measured by new product development and survival, which are two important early-stage performance measures for new ventures, who often do not primarily strive for long-term success as established ventures typically

do (Ambos & Birkinshaw, 2010). Most other studies on organizational change focused on established ventures, with only a few studies investigating how new ventures, during their earliest stages of formation, change and how that impacts their performance. Moreover, the few studies that did focus on this topic mostly adopted a case study approach. To my knowledge, this study is the first large sample study of organizational change in new ventures. Furthermore, this study focuses on emerging industries. Using a longitudinal sample of 173 new ventures in the emerging mobile health industry, we draw on the organizational change literature to make hypotheses. We hypothesize that business model change will have a positive impact on a firm's performance, and that a higher degree of business model change and time since last business model change will negatively affect performance. Moreover, we argue that degree of business model change and time since last business model change will interact, such that a longer time since last business model change combined with a higher degree of business model change will lead to a higher performance than a longer time since last business model change combined with a lower degree of business model change. Conversely, we argue that a shorter time since last business model change combined with a lower degree of business model change will lead to a higher performance than a shorter time since last business model change combined with a higher degree of business model change. This study makes contributions to the organizational change literature, as well as to the entrepreneurship literature by focusing on the impact on performance of organizational growth and evolution processes.

1.3. Research context and methodology

As mentioned in the short descriptions of these two empirical studies in the previous section, the emerging industry in which I study new ventures' business model change processes is the

emerging mobile health industry. In this section, I will give a short description on this industry, as well as provide an overview of the data collection techniques used in this dissertation.

Mobile health or mHealth refers to the use of mobile phones for health service and information. It contains, but is not limited to, applications such as wireless secure communication between physicians and hospitals, remote monitoring of elderly people, fitness and wellness applications, apps for monitoring diabetes, wireless transmission of prescriptions from doctors to pharmacists, and mobile systems for appointments with doctors.

The mobile health industry was chosen in this dissertation for several reasons. First of all, mHealth can be seen as an emerging industry (Istepanian, Pattichis, & Laxminarayan, 2006). Moreover, there is no one specific business model in the industry that every firm adopts in order to ensure their success, nor is it expected that this will ever be the case (MobiHealthNews, 2011). This diversity makes the mobile health industry an interesting setting to study business model changes. As the industry is still emerging, firms will also be more likely to undertake business model changes. Finally, the mHealth industry is characterized by an interplay of a larger number of different players, such as mHealth organizations, telecommunications providers, pharmaceutical companies, physicians and hospitals, the government, etc. The dependency between all these types of players requires that the business model of each player is adapted to, or at least takes into account, the other players on which a firm is dependent. This makes the mobile health industry an excellent setting for studying how an emerging ecosystem or network of alliance partners can influence a firm's business model.

The focus in this dissertation is on new ventures, i.e. ventures younger than eight years (Zahra, 1996), active in the mobile health industry that were independent ventures. Based on the MobiHealthNews and Rock Health reports, I was able to identify a sample of 239 ventures that

were founded between 2005 and 2013. After dropping several companies for various reasons, I ended up with a final sample of 193 new ventures. All data on business models, alliances and firm characteristics were collected based on secondary data sources, such as the MobiHealthNews reports, (archived) company websites, press releases, and databases such as the United States Patent and Trademark Office Website and the website of the US Food and Drug Administration.

More information on the sample and the data collection methodology will be provided in Chapter 3.

1.4. Objectives and expected contributions of dissertation

The overall objective of this dissertation is to identify the causes and consequences of new ventures' business model change processes in an emerging industry. More specifically, the first empirical study aims to understand how business model experimentation and the establishment of new alliances can influence new ventures' business model changes, as well as the degree to which these ventures change their business models. The objective of the second empirical study of this dissertation is to investigate how differential business model change processes, with regards to the degree of change and time in between business model changes, impact the performance of new ventures in an emerging industry.

This dissertation seeks to make several contributions to the understanding of business model change processes and their implications for the performance of new ventures in emerging industries.

First of all, this dissertation aims to find out why some new ventures change their business models and others do not, and relies on organizational learning and alliance theory to do so. Moreover, in addition to investigating which firms change their business models and which ones do not, this

dissertation also investigates how business model experimentation and alliances influence the degree to which firms change their business models. Few studies in the literature have focused on the early organizational change processes of new ventures in emerging industries, and even fewer studies investigate why some firms engage in more radical change than others. This dissertation will thus contribute to the entrepreneurship literature as it will provide insights into the evolution of new ventures. Moreover, it will extend the existing organizational change theory by focusing on new ventures in emerging industries.

Secondly, this study also investigates how business model change processes impact the performance of new ventures. Not only will it investigate if firms that changed their business models perform better than firms that did not change their business models, but it will also investigate how the degree of business model change and time in between business model changes influence the performance of new ventures. In doing so, this dissertation will make contributions to the organizational change literature which mostly focused on the impact of change on performance in established ventures. Moreover, the study also teases apart the effects of degree of business model change and time in between business model change, while most previous studies focused on either continuous, incremental change, or discontinuous, radical change.

Finally, by investigating the antecedents and consequences of business model change processes of new ventures in emerging industries, this dissertation will contribute to the entrepreneurship literature, whose primary focus is the birth, growth and performance of new ventures. The research in this dissertation will provide us with the knowledge of which firms are able to change and how much, and whether or not this change or lack of change is beneficial or detrimental for the performance of new ventures. As such, it provides valuable knowledge for practitioners in the process of starting their own venture as well as for government agencies, incubators and

accelerators that help new ventures in their early development. The findings of this dissertation will allow these organizations to help the new ventures they are guiding in undertaking business model change in response to their changing environment, as well as increase the chances that the undertaken change will have a positive impact on the performance of these new ventures.

1.5. Dissertation outline

This first chapter has set forth the broad research problem and the specific questions that will be examined in this dissertation, and has identified the research context and objectives of the dissertation. Chapter 2 reviews the previous research on business models, and gives an overview of the main research themes that have been studied, as well as the empirical commonalities of the business model studies that were published up till now. It serves as an overview of the business model literature, as well as an identification tool for gaps in the literature and for priorities for future research, that are subsequently addressed in the two empirical studies of this dissertation.

Chapter 3 gives an overview of the mobile health industry, which is the industry that serves as the research setting for this dissertation. It provides an overview of the history and characteristics of the mobile health industry, as well as the players that are active in this industry. Furthermore, I provide arguments as to why the mobile health industry is an appropriate setting for this dissertation. In the second half of the chapter, I then describe the target population of firms, how the sample was built and how the data was collected. I end the chapter with an operationalization of the constructs that will be used in the two empirical studies of this dissertation and by describing the main analytical techniques used to test the hypotheses in these two studies.

Chapter 4 describes the first empirical study of this dissertation, in which I adopt an organizational learning and alliance perspective to investigate the extent to which firms' past business model

experimentation processes and the alliances they establish predict the likelihood that the firms will engage in subsequent business model change. Moreover, I analyze the impact of experimentation and alliances on the degree to which new ventures change their business models. The chapter starts out by describing the relevant literature, before building and testing hypotheses, and describing the results and implications of this study.

Chapter 5 then describes the second empirical study of this dissertation, in which I analyze the impact of firms' organizational change processes, conceptualized as business model change, on their performance. Performance is measured by new product development and survival. I adopt an organizational change perspective and investigate to what extent business model change, the degree of business model change and the time between business model changes have an impact on new ventures' performance. The outline of this chapter is similar to the previous chapter: I describe the relevant literature, build and test hypotheses and describe the results and implications.

Finally, Chapter 6 discusses the theoretical and practical conclusions derived from the studies in this dissertation, and identifies limitations and areas for future research.

1.6. References

Ambos, T. C. & Birkinshaw, J. 2010. How do new ventures evolve? An inductive study of archetype changes in science-based ventures. ***Organization science***, 21(6): 1125-1140.

Amit, R. & Zott, C. 2001. Value creation in e-business. ***Strategic management journal***, 22(6-7): 493-520.

Andries, P., Debackere, K., & Van Looy, B. 2013. Simultaneous Experimentation as a Learning Strategy: Business Model Development Under Uncertainty. ***Strategic Entrepreneurship Journal***, 7(4): 288-310.

Blank, S. 2013. Why the lean start-up changes everything. ***Harvard Business Review***, 91(5): 63-72.

Casadesus-Masanell, R. & Zhu, F. 2010. Strategies to Fight Ad-Sponsored Rivals. ***Management Science***, 56(9): 1484-1499.

Casadesus-Masanell, R. & Llanes, G. 2011. Mixed Source. ***Management Science***, 57(7): 1212-1230.

Chesbrough, H. & Rosenbloom, R. S. 2002. The role of the business model in capturing value from innovation: evidence from Xerox Corporation's technology spin-off companies. ***Industrial and Corporate Change***, 11(3): 529-555.

Dorf, R. C. & Byers, T. H. 2008. ***Technology Ventures: From Idea to Enterprise***. New York: McGraw-Hill.

Furr, N. R., Cavarretta, F., & Garg, S. 2012. Who changes course? The role of domain knowledge and novel framing in making technology changes. ***Strategic Entrepreneurship Journal***, 6(3): 236-256.

Istepanian, R. S. H., Pattichis, C. S., & Laxminarayan, S. 2006. Ubiquitous M-health systems and the convergence towards 4G mobile technologies, ***M-Health***: 3-14: Springer.

Kim, S. K. & Min, S. 2015. Business Model Innovation Performance: When Does Adding a New Business Model Benefit an Incumbent? ***Strategic Entrepreneurship Journal***, 9(1): 34-57.

Lepoutre, J., Read, S., & Margery, P. 2012. TerraCycle (B): A Million Tradeoffs.

MobiHealthNews. 2011. Mobile Health Q4/Year-end 2010, ***MobiHealthNews***: Chester Street Publishing.

Morris, M., Schindehutte, M., & Allen, J. 2005. The entrepreneur's business model: toward a unified perspective. ***Journal of Business Research***, 58(6): 726-735.

Santos, F. M. & Eisenhardt, K. M. 2009. Constructing markets and shaping boundaries: Entrepreneurial power in nascent fields. ***Academy of Management Journal***, 52(4): 643-671.

Sosna, M., Trevinyo-Rodríguez, R. N., & Velamuri, S. R. 2010. Business model innovation through trial-and-error learning: The Naturhouse case. ***Long range planning***, 43(2): 383-407.

Teece, D. J. 2010. Business models, business strategy and innovation. ***Long range planning***, 43(2): 172-194.

Vise, D. A. & Malseed, M. 2006. The Google Story–Inside the Hottest Business, Media and Technology Success of Our Times. ***Pan Macmillan, London***.

Zahra, S. A. 1996. Technology strategy and new venture performance: A study of corporate-sponsored and independent biotechnology ventures* 1. ***Journal of Business Venturing***, 11(4): 289-321.

2.REVIEW OF THE BUSINESS MODEL LITERATURE

2.REVIEW OF THE BUSINESS MODEL LITERATURE

In this chapter, I will provide an overview of the academic literature on business models as well as on the most current research themes and the remaining gaps in the literature. The main goal of this review is to provide an overview of the existing literature, so as to allow a better understanding of the positioning of the two empirical studies of this dissertation in the existing literature.

I will start this chapter by a short overview of the search approach that was used and the papers that were included in this chapter. Then, I will compare this review chapter to the main review paper on business models that has been published in the academic literature. Next, I will discuss the most common research topics addressed and methods used in the business model literature, as well as some current gaps in the literature. Finally, I end this chapter by combining the gaps in research topics and empirical methods used in the business model literature and by showing how the main two studies of this dissertation address some of these gaps.

2.1 Methodology

I followed several steps to conduct this review of studies on business models. First of all, the scope of the review was constrained to research published in top management and entrepreneurship journals (Wang & Rajagopalan, 2014). These journals were *Academy of Management Journal (AMJ), Academy of Management Review (AMR), Administrative Science Quarterly (ASQ), Entrepreneurship Theory and Practice (ETP), Journal of Business Venturing (JBV), Journal of Management (JOM), Journal of Management Studies (JMS), Management Science (MS), Organization Science (OS), Research Policy (RP), Strategic Entrepreneurship Journal (SEJ)* and

Strategic Management Journal (SMJ). I conducted a topic search, using *"business model"* and *"business models"*, as the keywords to identify relevant articles in the *Web of Science* database. I did not specify a timeframe in which the studies had to be published, but due to the fact that academic studies on business models were scarce before 2000, the oldest studies included in this review were published in 2001. 72 articles were published in these journals that met the keyword search. I then examined the titles and abstracts of all articles and dropped papers that were not pertinent to this topic. The main reasons why studies were dropped from the sample were the fact that papers only mentioned the term "business model" in the keywords but nowhere else in the paper (e.g. Parker & Van Alstyne, 2005); or business models were mentioned a couple of times in the article but were not its core focus, nor did the researchers make a significant contribution to the business model literature (e.g. Bergek, Berggren, Magnusson, & Hobday, 2013). This was done to avoid including articles in the review that only deal with business models in a trivial or marginal way (Zott, Amit, & Massa, 2011). Moreover, review articles (e.g. Zott et al., 2011) or the guest editors' introduction to a special issue (e.g. Demil, Lecocq, Ricart, & Zott, 2015) were also not included in this review. As a result, the final number of articles included in this review is 34. For each of these 34 articles, I coded the sample, data source and analytic methods (where applicable), theoretical constructs, key findings, and underlying theoretical perspectives. I used this coding as the basis for both the theoretical and empirical review of these papers. Table 2.1 below gives an overview of the number of papers per journal that were found using *Web of Science*'s keyword search for "business model" and "business models" and the number of articles retained in this review.

Table 2.1 – Overview of articles per journal

	AMJ	AMR	ASQ	ETP	JBV	JOM	JMS	MS	OS	RP	SEJ	SMJ	TOTAL
FOUND	2	2	0	11	2	2	5	12	5	15	8	8	72
RETAINED	0	0	0	3	0	0	3	7	2	9	7	3	34

Figure 2.1 below, which shows the distribution per year of the articles in this review paper, confirms Zott et al. (2011)'s observation that there is an increasing interest of academics in business models.

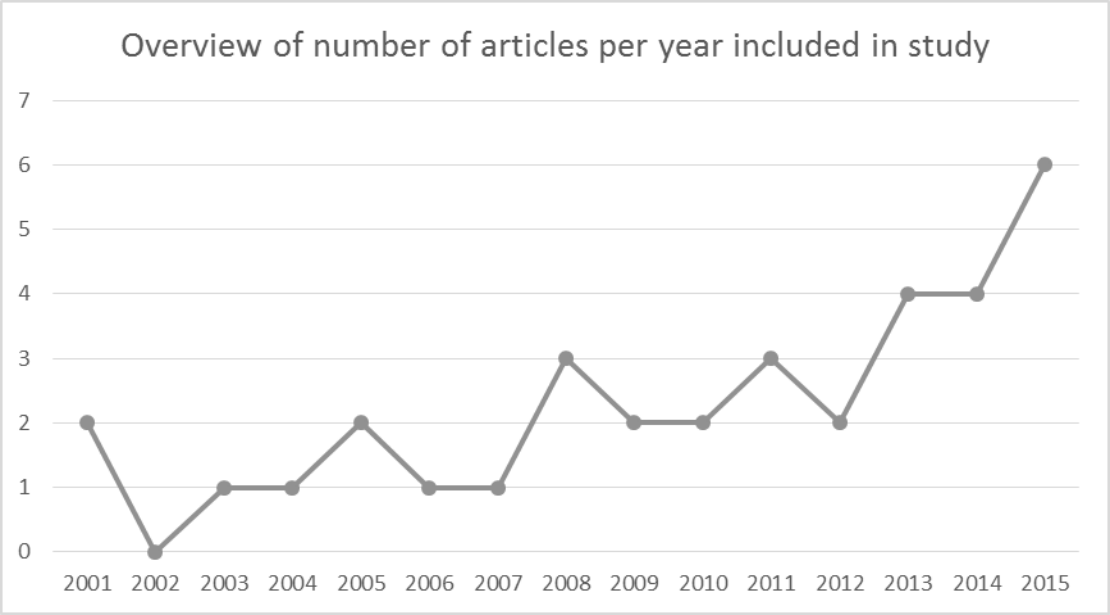


Figure 2.1 – Overview of articles included in this study per year

2.2 Positioning compared to previous review paper

In this section, I will shortly outline the differences between this review chapter and the major review paper on business models that has been published in the academic literature so far, which is the paper by Zott et al. (2011). While discussing the differences between the Zott et al. (2011)

paper and this review chapter, I will also provide more information on the specific goals of this chapter within the context of this dissertation.

First of all, Zott et al. (2011) include articles from both academic and practitioner-oriented articles in their review paper. As such, their review provides a broader overview of the business model concept. On the other hand, their review only includes papers published until 2009. Figure 2.1 above shows that the number of papers being published on business models is rapidly increasing. As such, the Zott et al. (2011) review may not capture some of the more recent trends in the business model literature. This chapter, as a more recent review on business models, should thus capture some of the more recent trends in the business model literature.

Secondly, Zott et al. (2011) mainly focused on identifying theoretical gaps and research themes in the business model literatures. Some of the themes they discussed were the emergence of the business model concept and definitions, business models and strategy, such as value creation and capturing activities, and business model innovation. These three topics are also present in this review chapter. Some additional common topics that are described in this chapter that were not included in Zott et al. (2011)'s paper are the focus on business models in specific contexts and industries, the adoption of (innovative) business models, and business model change processes. Moreover, in this review chapter, I also look at the main methods used in business model studies and combine them with some of the research topic gaps. As such, this chapter gives an overview of some gaps in the existing business model literature that are caused by a lack of a specific type of research method, e.g. a lack of quantitative studies, that has focused on a specific topic. This allows me to better position the two empirical studies of this dissertation in the existing literature, both from a theoretical and empirical point of view.

A third difference is that Zott et al. (2011) paper aims to situate the existing business model literature in three main theories, i.e. the e-commerce, strategy, and technology and innovation management theories. This review chapter, on the other hand, does not take one or multiple overarching theories as a map to situate the reviewed business model papers. The goal of this chapter is mainly to provide an overview of the most common research themes and methods used in the business model literature that can then be used as a map to position the two empirical studies of this dissertation.

The main contribution of this chapter is thus not the theoretical or methodological advancement of the business model concept, but rather the overview it provides of the literature that allows for a clear positioning of the two empirical papers of this dissertation.

2.3 Overview of business model literature: research themes

As mentioned earlier, an increasing number of scholars have published academic studies on business models in the last decade (Zott et al., 2011). In this section, I will give an overview of the most common research themes that have been addressed in these studies. A list of all papers included in this review, as well as the research questions they addressed, the theoretical lenses they adopted and their main findings can be found in Table 2.2.

2.3.1 What are business models and what do they do?

Despite the increasing number of studies on business models, there has been no consensus on what exactly a business model is (Zott et al., 2011). In their review of business models, Zott et al. (2011) show no less than seven different business model definitions that have all been cited by various other papers. Due to these different definitions of business models, scholars usually pick the

definition that best fits their needs (Zott et al., 2011) or just use the term business model without properly defining the concept (Zott & Amit, 2013).

In the 34 studies included in this review, there are three papers in which the authors try to define what business models are or what exactly business models do. The study by Amit and Zott (2001) can be seen as one of the first academic publications on business models. Their starting point is determining which theoretical foundations can explain the value creation of e-businesses and find that none of the existing entrepreneurship or strategic management theories can explain this phenomenon. To this end, they introduce the business model as "the content, structure, and governance of transactions designed so as to create value through the exploitation of business opportunities" (Amit & Zott, 2001, p. 511). Subsequently, they identify the four ways in which business models can create value for e-business firms.

In their study, George and Bock (2011) studied how practitioners define business models. They found that a business model is an organization-level phenomenon, "an architecture or design that incorporates subsystems and processes to accomplish a specific purpose" (George & Bock, 2011, p. 97). It is not a purpose or a process, nor is it the reason that the organization exists. Some of the business model's aspects overlap with the firm's revenue model, and the sampled practitioners further state that the business model is clearly distinct from an organization's corporate strategy.

In the third study that focuses on what business models are or what they do, Doganova and Eyquem-Renault (2009) focus on the latter. They use the case of an academic spin-off, and investigate the role that business models can play in the innovation process. They show that business models are a narrative and calculative device that can allow entrepreneurs to explore a market and can also contribute to the construction of the techno-economic network of an

innovation, thereby potentially having an impact on the firm's performance (Doganova & Eyquem-Renault, 2009).

While only three studies were summarized here, there are a lot more studies, often in practitioner journals, that focus on what exactly business models are or what they do, e.g. Johnson, Christensen, and Kagermann (2008) and Magretta (2002). The high number of studies that have attempted to define and clarify what business models exactly are, is partly driven by the complexity of the concept. Business models do not only focus on the focal firm, but also on its stakeholders and on how a firm's business model can create value to all stakeholders (Zott & Amit, 2013). This complexity, combined with the myriad of studies that have focused on defining and conceptualizing business models, has also lead to the increased confusion and lack of clarity of the concept. As a result, it is important that researchers clearly specify how they define business models and ensure that their theoretical framing and empirical methods are in line with the chosen definition of a business model (Zott & Amit, 2013).

The definition of business model that was chosen in this dissertation is the one by Chesbrough and Rosenbloom (2002, p. 532), who define a business model as "a coherent framework that takes technological characteristics and potentials as inputs and converts them through customers and markets into economic outputs". It was chosen because it gives a relatively clear overview of what a business model is and does, and because there is a close fit between this definition and the categorization scheme that was used to measure the business model variables in the two empirical studies of this dissertation (infra).

2.3.2 Studies on business models for specific industries or settings

A second set of studies focuses on business models applicable to specific industries or settings, such as e-business or biotechnology. Studies in this category either investigate which business models are prevalent in the industry (e.g. Amit & Zott, 2001; Mangematin et al., 2003) or why certain business models exist in a certain industry (e.g. Lazonick & Tulum, 2011).

In their study on e-business, Amit and Zott (2001) determine the four dimensions on which the value creation potential of e-businesses hinges. In another study on e-business, Ding, Eliashberg, Huber, and Saini (2005) develop a model for a reverse auction type of website and model the behavior of customers using such a website. There are also two studies in this review that focus on the biotech industry. The first one studies 60 French biotech firms, and shows that, in addition to the dominant business model in which biotech firms attract venture capital (VC) funding and eventually aim for an IPO, there is a second existing business model. In this second business model, the biotech firms prefer to target local markets or prefer not to be listed on the stock exchange (Mangematin et al., 2003). The second study on biotech focuses on why venture capitalists and pharmaceutical companies are willing to invest in the biotech industry, in which profits are hard to come by (Lazonick & Tulum, 2011). Two other studies also focus on business models for a specific industry. Lehoux, Daudelin, Williams-Jones, Denis, and Longo (2014) use a sample of Canadian academic spin-offs to show how business model and health technology design influence each other. Finally, a study by Mina, Bascavusoglu-Moreau, and Hughes (2014) investigates open innovation processes in services and shows how this process influences the adoption of a service inclusive business model.

The cited studies have all focused on a specific industry, such as biotech, e-business or health services. While there are four main ways in which firms can create value, i.e. through efficiency, novelty, complementarities or lock-in (Amit & Zott, 2001; Zott & Amit, 2013), a business model

needs to be modified to a specific industry and the players active in that industry. As a result, empirical studies on business models should focus on a specific industry to ensure the homogeneity of the chosen sample. The single industry that will be used in the two empirical studies of this dissertation is the mobile health industry.

2.3.3 Impact of business models on performance

In addition to these more descriptive studies on firms' business models, there are also a group of studies that investigate the impact of a firm's business model on its profits or performance. In the first two studies on this topic, Zott and Amit (2007, 2008) investigate the impact of efficiency- and novelty-based business models on a firm's performance. Moreover, they also investigate how the fit between a firm's business model and its product market strategy will have an impact on the firm's performance (Zott & Amit, 2008). Chandler, Broberg, and Allison (2014) show how firms' business model choices can impact their performance in declining industries, and Brea-Solis, Casadesus-Masanell, and Grifell-Tatje (2015) investigate Walmart's business model choices and the impact these choices had on the organization's profit. Gerasymenko, De Clercq, and Sapienza (2015) focus on how venture capital firms and outside CEO's can increase the performance of firms that have changed their business models. Finally, a study by Kim and Min (2015) adopts the perspective of the incumbent and investigates how an incumbent firm's performance is affected by its decision to add a new business model to its existing line of business models.

All of these studies have shown that business models can have an important impact on a firm's performance. As a result, a firm should build its business model with care and should pay attention to the fit between a firm's business model and its strategy, e.g. its product market strategy, as this fit can increase the performance of a firm (Zott & Amit, 2008).

Table 2.2 – Overview of business model literature: theoretical perspective

	Article	Research question	Theoretical lens	Main findings	Type of paper
1	Amit & Zott (2001)	What are the sources of value creation in e-business?	Value chain analysis, Schumpeterian innovation, resource-based view, strategic network theory, transaction cost economics	Value creation of e-business hinges on four interdependent dimensions: efficiency, complementarities, lock-in, and novelty. The business model concept is introduced as a unit of analysis to explain this value creation potential of e-business.	Empirical, qualitative study
2	Winter & Szulanski (2001)	How do replicators discover and refine their business models?	Dynamic capabilities	Replication is a process that involves exploration in which the business model is created and refined, followed by an exploitation phase, in which the business model is stabilized and leveraged through large-scale replication	Empirical, qualitative study
3	Mangemati n et al. (2003)	What is the pattern of development of the biotech sector? What are the patterns of development of firms?	Business model perspective	Not all biotech firms adopt the business model of relying on growth forecasts to persuade capital investors to invest in a radical innovation project, aim for international markets and IPO's. Study shows that some firms prefer to target local markets or to not be listed on the stock exchange.	Empirical, quantitative study
4	Dye (2004)*	How does accounting information affect firms' strategy choices when profit drivers are uncertain?	Accounting, agency, decision-making under uncertainty	This study creates a model of manager's strategic decision making under uncertainty and identifies necessary and sufficient conditions for experimentation. It also identifies the actors that influence a firm's preferred performance measurement system and explains why this will likely change over time.	Development of mathematical model
5	Ding et al. (2005)	How do consumers behave in a reverse auction?	Economic theory, emotions	This study develops a model for and tests the impact of expected excitement at winning, and frustration at losing, on bids across consumers and bidding scenarios, as well as on the dynamic nature of the bidding behavior, thereby creating insights into the user behavior of reversed auction websites	Development of mathematical model + empirical test of this model
6	Tang (2005)	How do new digital copyright laws affect innovation on the Internet?	Patents, regulatory processes	Digital copyright laws have mostly had a positive impact on innovation, and have also led to the adoption of new business models in the entertainment industry. However, some technologies' development were also slowed down by the new laws.	Empirical, qualitative study

	Article	Research question	Theoretical lens	Main findings	Type of paper
7	Bonaccorsi et al. (2006)	What business models do new entrants adopt? What are the determinants of the degree of openness to open source (OS)? Are the observed business models stable?	Strategic decision-making, business models	The large majority of firms follow a hybrid business model (and thus not a pure open source model). Switching costs and network externality effects negatively influence the degree of openness, whereas the experience gained in working on community projects has a positive impact on the degree of openness. Finally, the hybrid business models are not a transient stage in the industry.	Empirical, quantitative study
8	Zott & Amit (2007)	How can business model design be measured, and how does it affect firm performance?	Business models, organization design	Novelty-centered business model design matters to the performance of entrepreneurial firms. Entrepreneurs' attempts to incorporate both efficiency- and novelty-centered design elements into their business models can be counterproductive.	Empirical, quantitative study
9	Fiet & Patel (2008)*	What are the attributes of forgiving business models?	Asymmetric information, time, search costs, risk aversion	There are two primary approaches for creating a forgiving business model: 1) by increasing a resource provider's market interaction costs, and 2) by reducing a resource provider's relative outside options	Theory paper
10	Mason & Leek (2008)	How can learning and knowledge transfer take place in the context of dynamic business models?	Inter-firm knowledge transfer, business model, structures and routines	Dynamic business models help organizations identify and link key actors with each other, and aid the identification and specification of appropriate knowledge types and knowledge transfer mechanisms for different actors, in different contexts.	Empirical, qualitative study
11	Zott & Amit (2008)	How do the firm's business model and its product market strategy interact to impact firm performance?	Contingency theory, business models, fit	Business model and product market strategy are complements, not substitutes. Novelty-centered business models combined with product market strategies that emphasize differentiation, cost leadership, or early market entry, can enhance firm performance.	Empirical, quantitative study.
12	Björkdahl (2009)	How do technology opportunities arise from "cross-fertilizing" and how do firms appropriate economic value from their technical potential?	Value creation and appropriation, multi-technology firms	Technology cross-fertilization needs to be accompanied by business model changes in order to achieve increased economic value.	Empirical, qualitative study
13	Doganova & Eyquem-Renault (2009)	What do business models really do?	Market devices, boundary conditions	The business model is a narrative and calculative device that allows entrepreneurs to explore a market and it plays a performative role by contributing to the construction of the techno-economic network of an innovation.	Empirical, qualitative study

	Article	Research question	Theoretical lens	Main findings	Type of paper
14	Casadesus-Masanell & Zhu (2010)*	How should an incumbent react to an ad-sponsored entrant?	Ad-sponsored business models, product-line extension, competitive interaction, two-sided markets	The optimal response to an ad-sponsored rival often entails business model reconfigurations. Incumbents are more likely to prefer to compete through subscription-based or ad-sponsored models when facing an ad-sponsored entrant.	Development of mathematical model
15	Dewald & Bowen (2010)	Which factors determine a small incumbent firm's response to disruptive innovations? Which factors influence the cognitive intentions of managers of small incumbent firms facing a pending disruption?	Cognitive framing, risk experience, urgency	There is a threat rigid response that predicts an increased likelihood of resistance when managers perceive business model innovation as a threat, and increased likelihood of adoption when the innovation is perceived as an opportunity. Urgency moderates threat, and risk experience moderates opportunity in predicting intentions to adopt.	Empirical, quantitative
16	Casadesus-Masanell & Llanes (2011)*	When will a profit-maximizing firm adopt a mixed-source business model? How is the desirability of mixed source affected by the quality of the firm's software compared to that of competitors? Which technologies will be open and which ones will remain closed? How do these decisions depend on the compatibility regime between the products of the firm and those of its competitors?	Open source, optimal business models, equilibrium market structure, competitive interaction	When the firm's modules are of high quality, the firm is more open under incompatibility than under compatibility; firms are more likely to open substitute, rather than complementary, modules to existing open-source projects; there may be no trade-off between value creation and value capture when comparing business models with different degrees of openness	Development of mathematical model
17	George & Bock (2011)	What are business models and how do practitioners use them?	Organizational design, resource-based view, organizational narrative, innovation, opportunity facilitation, transactive structures	The underlying dimensions of the business model are resource structure, transactive structure, and value structure.	Empirical, quantitative
18	Lazonick & Tulum (2011)	Why would money from venture capitalists and big pharma flow into an industry in which profits are so hard to come by?	Biotechnology, financing	The study shows that stock-market investors have been willing to absorb the IPOs of biopharmaceutical ventures that have not yet generated a commercial product. Another factor is that the knowledge base that biopharmaceutical companies use to develop their products mostly comes from government investments and spending, rather than from business finance.	Empirical, qualitative

	Article	Research question	Theoretical lens	Main findings	Type of paper
19	Bock et al. (2012)	How do firms attain strategic flexibility?	Structures and capabilities, business model innovation, creative culture, structural change, partner reliance	The relative magnitude of business model innovation effort moderates the effect of reconfiguration on strategic flexibility.	Empirical, quantitative
20	Halme et al. (2012)	Which mechanisms lead to inclusive business innovations?	Bricolage, intrapreneurship	Intrapreneurial bricolage may be of fundamental importance in multinational corporations' innovations for inclusive business	Empirical, qualitative
21	Andries et al. (2013)	How do ventures develop their business models through experimentation? Do different experimentation and learning approaches exist? What are the rationale and implications of these approaches?	Business models, organizational learning theory	There are two approaches to business model development: focused commitment and simultaneous experimentation. Focused commitment positively affects initial growth, but jeopardizes long-term survival. Simultaneous experimentation, on the other hand, implies lower initial growth levels, but facilitates long-term survival.	Empirical, qualitative
22	Casadesus-Masanell & Zhu (2013)*	Under what circumstances will an entrant benefit from adopting a new business model when the innovation may be imitated by an incumbent?	Innovation, imitation, competitive dynamics, practice diffusion, unawareness, platforms and multisided markets	An innovative entrant needs to strategically choose whether to reveal its innovation by competing through the new business model, or conceal it by adopting a traditional business model. The value of business model innovation may be so substantial that an incumbent may prefer to compete in a duopoly rather than to remain a monopolist.	Development of mathematical model
23	Desyllas & Sako (2013)	How can incumbent firms profit from business model innovation with the availability of business method patenting?	Business models, innovation, IP	Formal and strategic IP protection methods play complementary roles. Formal IP rights are first used as a defensive strategy and as a means of "buying time" to build specialized complementary assets. Long-term competitiveness depends on whether the innovator builds a strong position in specialized complementary assets and is capable of reconfiguring them over time in line with changes in the market environment.	Empirical, qualitative
24	Suarez et al. (2013)	What is the role of services in the overall firm performance of product firms?	Services, business models, performance.	Firms with a very high level of product sales are most profitable, and rising services are associated with declining profitability. Additional services, however, start to have a positive marginal effect on the firm's overall profits when services reach a majority of a firm's sales.	Empirical, quantitative

	Article	Research question	Theoretical lens	Main findings	Type of paper
25	Bohnsack et al. (2014)	How does the extent to which incumbent and entrepreneurial firms are driven by path-dependent behavior affect business model evolution in an emerging industry?	Sustainable technologies, business models, path-dependent behavior	Incumbent and entrepreneurial firms approach business model innovation in distinctive ways. Business model evolution shows a series of incremental changes that introduce service-based components that were originally developed by entrepreneurial firms, to the product. There seems to be some convergence in the business models of incumbents and entrepreneurs over time.	Empirical, qualitative
26	Chandler et al. (2014)	How do firms grow rapidly when they are competing in declining industries?	Institutional theory, business models	High-growth firms develop value propositions that differ substantially from industry representative firms. High-growth firms communicate their value propositions more clearly and aggressively than industry representative firms.	Empirical, qualitative and quantitative
27	Lehoux et al. (2014)	How do business models and health technology development influence each other?	Business models, spin-offs, technology development	There are mediating mechanisms by which business models and technology design influence each other. The study also suggests that it is not only who makes decisions that matters, but also how stakeholders' value expectations get embedded in a spin-off's value proposition.	Empirical, qualitative
28	Mina et al. (2014)	What do open innovation processes look like in service firms?	Open innovation, business models, services	Business services are more active open innovators than manufacturers. Open innovation practices are also associated with the adoption of a service inclusive business model in manufacturing firms and service-integrated manufacturers engage in more knowledge-exchange activities.	Empirical, quantitative
29	Brea-Solís et al. (2015)	How do firm's business model choices impact their profit consequences?	Business models, business performance	The effectiveness of a particular business model depends not only on its design, but most importantly, on its implementation.	Mathematical modelling and qualitative empirical
30	Casadesus-Masanell & Hervas-Drane (2015)*	How do the provision and disclosure of customer information shape the competitive interaction of firms?	Privacy, advertising, two-sided markets, marketplace intermediation	Competition drives the provision of services with a low level of consumer information disclosure, but higher competition intensity in the marketplace does not necessarily improve privacy when customers exhibit low willingness to pay.	Development of mathematical model
31	Gerasymenko et al. (2015)	How do venture capital firms (VCF) have an impact on the performance of young ventures that have substantially changed their business models?	Business models, venture capital firms, experience, CEO	The scope of VCF involvement positively impacts the portfolio company's (PFC) performance. The VCF's experience with business model change and the recruitment of an outside CEO to the PCF increase the positive impact of VCF involvement.	Empirical, quantitative

	Article	Research question	Theoretical lens	Main findings	Type of paper
32	Kim & Min (2015)	When does adding a new business model benefit an incumbent?	Business model innovation, aligning assets	Incumbent performance after new business model addition improves when the incumbent firm aligns complementary assets with earlier addition of the new business model and conflicting assets with an autonomous business unit for the new business model.	Empirical, qualitative
33	Martins et al. (2015)*	Which mechanisms enable business model innovation in the absence of exogenous change?	Business models, cognition	This study contributes to the cognitive perspective in strategy by analyzing business models as schemas that organize managerial understandings about the design of firms' value-creating activities and exchanges. Moreover, the study proposes two major firm-level strategic cognitive processes, analogical reasoning and conceptual combination, for designing innovative business models.	Theory paper
34	Osiyevskyy & Dewald (2015)	What is the role of cognitive antecedents in incumbents' decisions to adopt a new business model or not?	Disruptive innovation, cognition	Incumbents' explorative intentions are driven by opportunity perception, perceived performance-reducing threat and risk experience. Exploitative intentions are negatively associated with perceived critical threat and industry tenure and positively associated with risk experience.	Empirical, quantitative

* indicates a non-empirical study. These studies will not be included in Table 2.3, which summarizes the sample characteristics of the studies.

2.3.4 Business model innovation: studies on how to build innovative business models

There are largely two groups of studies within those that focus on business model innovation, which is the process of introducing a business model new to the focal firm's industry (Snihur, 2013). The first group focuses on which factors drive or encourage business model innovation, while a second group of studies focuses on specific cases of business model innovation and the advantages business model innovation can bring to a firm.

Within the first group, Halme, Lindeman, and Linna (2012) investigate which mechanisms can lead to inclusive business model innovations, meaning business model innovation that will ensure that the firm will end up with a business model that extends choices to the poor, i.e. an inclusive business model. The authors find that bricolage behavior by an intrapreneur can help firms achieve this kind of business model innovation. Lehoux et al. (2014) study how business model and health technology design influence each other in the case of academic spin-offs and how this interplay can help achieve business model innovation. A final study on antecedents of business model innovation is a theory study that argues how entrepreneurs' cognition, more specifically analogical reasoning and conceptual combination, can lead to business model innovation (Martins, Rindova, & Greenbaum, 2015).

In the second group of business model innovation papers that focuses on specific instances of business model innovation, Fiet and Patel (2008) focus on "forgiving business models". Forgiving business models transfer some of the risk of starting up a venture to the investors and other stakeholders, while the entrepreneurs still maintain the same levels of profit-sharing as they would have without this risk transfer. In a second specific study of business model innovation, the authors demonstrate how business model innovation can moderate the effect of reconfiguration processes on strategic flexibility (Bock, Opsahl, George, & Gann, 2012).

Business model innovation is an important concept as it introduces novel business models in an existing industry. These novel business models can then later be adopted by other firms and can potentially become the standard business model later on in an industry. Gaining more insights in the factors that drive business model innovation, and thus the creation of a business model that is new to an industry, and the advantages that business model innovation can have for firms that choose to build a novel business model, is important.

2.3.5 Adoption of innovative business models by incumbents, replicators and new entrants

This group of studies is related to the previous group, which focused on antecedents and consequences of business model innovation. The studies in this section also focus on business model innovation, but on the adoption thereof. These studies focus on how and why incumbents, new entrants and replicating businesses such as franchising companies, adopt innovative business models.

One of the first studies that focused on the adoption of business models was a study by Winter and Szulanski (2001), which aimed to understand how replicating firms, such as McDonalds, replicate their business models in their different locations and on how this business model evolves as more and more of its locations adopt it. Some other studies focus specifically on new entrants into an industry and on which business models they should adopt. Bonaccorsi, Giannangeli, and Rossi (2006)'s study, for example, focuses on the extent to which new firms should adopt open source in their offerings and whether this initial choice will remain stable or change over time. The authors do not view open source as a mere technology choice, in the sense that it affects the way in which software is produced and distributed. They argue that the choice for open source also affects the way products and services are sold to customers, how cash is generated and income is produced (Bonaccorsi et al., 2006), making this a choice of business model, rather than a technology choice.

Casadesus-Masanell and Zhu (2013) look at it from another perspective. They focus on new entrants that have an innovative business model, and investigate the circumstances under which these new entrants should adopt their own, innovative, business model or should adopt the predominant business model in the market, to avoid that incumbents would copy and adopt their innovative business model. They also show that the value of the innovative business model may be so substantial that an incumbent may prefer to adopt in and compete in a duopoly rather than to remain a monopolist, while maintaining their original business model.

While the previous papers focused on the adoption of innovative business models by new entrants and replicating firms, the majority of papers on the adoption of business models focused on incumbents' responses to new entrants in the market that bring an innovative business model with them. Two studies by Casadesus-Masanell for example (Casadesus-Masanell & Llanes, 2011; Casadesus-Masanell & Zhu, 2010), develop a mathematical model for incumbents' responses to new entrants in the market in the context of ad-sponsored or open source business models. Other studies investigate how factors, such as perceived opportunities and threats, determine whether incumbents will adopt the new entrant's business model (Dewald & Bowen, 2010; Osiyevskyy & Dewald, 2015) or focus on the consequences of adopting the new entrant's business model on the incumbent's performance (Kim & Min, 2015). Kim and Min (2015) found that, as an incumbent, adopting a new business model earlier will increase performance when the firm has complementary assets; when the firm has conflicting assets, the incumbent can mitigate the negative effect of adopting the new business model by setting it up in an autonomous business unit. Bohnsack, Pinkse, and Kolk (2014), finally, focus on the evolution and adoption of innovative business models by new entrants and incumbents in the electric vehicle industry.

There have thus been several studies that focused on the adoption of innovative business models, Although the majority of research on business model innovation and the adoption of innovative business models has focused on the actions of incumbents, tentative steps have been taken to study the actions of new ventures in relation to innovative business models (Casadesus-Masanell & Zhu, 2013). This work indicates that a new entrant's choice of implementing an innovative business model, may be driven by factors other than the availability of an innovative business model, such as the desire to protect its business model from incumbents that could copy it. As such, this study shows that business model innovation and adoption by new entrants can be seen as two distinct processes, and warrants that more research should focus on business model innovation and adoption of innovative business models by new ventures.

2.3.6 Business model change processes

This group of studies focuses on firms' business model change processes. Business model change or business model experimentation processes refer to changes in a firm's business model configuration as the firm learns about the environment and incorporates information that becomes available during the entrepreneurial trajectory (Andries, Debackere, & Van Looy, 2013; Gruber, MacMillan, & Thompson, 2008). The difference with business model innovation or the adoption of innovative business models is that the business model changes undertaken by the firm do not need to lead to a business model that is novel to the industry, as is the case with business model innovation. Studies focusing on business model change thus merely focus on how firms change their business models, what drives this change and how this change can impact performance.

There are three studies in this review that focus on business model change. The oldest one is by Mason and Leek (2008), who show that dynamic business models, which are "the emergent outcomes of preconceived network structures built through the development of routines that guide

problem solving" (Mason & Leek, 2008, p. 774), help organizations identify and link key actors with each other. Björkdahl (2009)'s study, while not primarily focusing on business model change, shows how technology cross-fertilization needs to be accompanied by business model changes in order for an organization to achieve increased economic value. The most relevant paper on business model change is the paper by Andries et al. (2013), which adopts an organizational learning perspective while studying new ventures' business model change processes. The authors propose two mechanisms – simultaneous experimentation and focused commitment, which can explain firms' business model change processes and also investigate the impact of these two approaches on the firms' performance.

While most scholars agree that business model change is an important concept, especially in emerging industries (Bohnsack et al., 2014) and for new ventures (Andries et al., 2013; Blank, 2013), the topic of business model change or evolution has mostly been studied in more practitioner-oriented studies. As a result, more academic studies should focus on gaining a deeper understanding of the process of business model change, such as on its antecedents, underlying mechanisms and performance implications.

2.3.7 Studies with a related topic, but with only a marginal focus on business models

A final group of papers included in this review are papers whose primary focus is not on business models, but on related aspects such as value creation and strategic decision-making (Desyllas & Sako, 2013; Dye, 2004; Suarez, Cusumano, & Kahl, 2013). Additional papers included in this section mostly focus on other topics, but have some implications for the business model literature. Tang (2005), for example, investigates the impact of new digital copyright laws on innovation in the music industry, and shows that these laws have also led to the increased adoption of innovative

business models, while Casadesus-Masanell and Hervas-Drane (2015) develop a mathematical model for the impact of customers' privacy on the competitive interaction between firms.

While these studies mention business models or have contributions that are related to the concept of a business model, they do not really focus on business models. This is possibly due to the complexity of the business model concept or due to the fact that a business model is related to other concepts such as a firm's product market strategy and the firm's governance of and relationships with its stakeholders (Amit & Zott, 2001; Zott & Amit, 2008). As the business model literature is starting to converse with regards to consistent themes within the business model definition (Zott & Amit, 2013), it is possible that there will be fewer instances of papers that use the term "business model" without actually drawing on or contributing to that literature stream in future research.

2.4 Overview of business model literature: empirical perspective

In this section, I provide a short overview of the advantages and disadvantages of the different empirical methods that are most common in the business model literature (see also Table 2.3 for a list of all the papers included in this review, as well as a summary of their methods and samples used). I begin with qualitative studies, as 15 out of the 34 papers in this review used this approach, followed by the quantitative approach (13 studies) and mathematical modelling (7 studies)[1].

2.4.1 Qualitative studies

In qualitative studies, the researcher uses a small sample, typically ranging from 1 (single case study) to around 10 cases (multiple case study). In this review, the unit of analysis ranged from

[1] Of the 34 studies, two are pure theory papers, and five pure mathematical modelling papers. Three of the empirical papers use a mixed method (mathematical model + quantative or qualitative, or qualitative + quantitative).

individual firms (e.g. Andries et al., 2013) to the entire industry (e.g. Tang, 2005). Researchers often use qualitative research when there is not enough theory available to guide them into making a research question that could be tested in a quantitative study (Eisenhardt, 1989). Qualitative research is thus particularly well suited for theory building and gaining initial understanding in new or underresearched phenomena. Qualitative research is intensive and usually requires cooperation and access to a lot of information from the sampled organizations. While the greater access to information is advantageous, it can also be difficult to convince organizations to provide access to their private information. Even if these organizations are willing to participate, qualitative studies may require long observation periods, and thus can take a long time before enough information is available to the researcher. Moreover, due to the small number of observations in settings that are usually quite narrow, the selected cases may not be an accurate representation of other firms, and the findings may thus not be generalizable (Johnson & Christensen, 2008; Litchman, 2006). Finally, even though different information sources are typically available to researchers conducting a qualitative analysis, the findings are to a certain extent always subjective, as they are interpretations by the researchers based on the available information, rather than outcomes of mathematical models or statistical techniques such as regression (Johnson & Christensen, 2008; Litchman, 2006).

2.4.2 Quantitative studies

Quantitative studies are typically executed when there is a certain amount of research on the topic available that can assist the researcher in formulating a research question that is sufficiently detailed such that hypotheses can be formulated that can be tested by statistical methods such as regression analysis (Johnson & Christensen, 2008; Litchman, 2006). The advantage of quantitative research is that, due to the larger sample used, its findings are typically more generalizable to other

populations. Moreover, the findings are the results of statistical methods, and are therefore less subject to interpretation by the researcher. On the other hand, quantitative studies are typically narrower than qualitative studies, and can thus only be executed when there is sufficient knowledge about the topic at hand. This knowledge will typically be generated by means of qualitative studies, which reduces the applicability of quantitative studies. In this review, 11 papers used a quantitative approach, and a large number of these studies focused on relatively straightforward research questions such as investigating the impact of business models on performance (Gerasymenko et al., 2015; Suarez et al., 2013; Zott & Amit, 2007, 2008) or on the factors that determine firms' choices to adopt a new business model (Bonaccorsi et al., 2006; Dewald & Bowen, 2010; Osiyevskyy & Dewald, 2015). Quantitative research is thus more limited in scope than qualitative research.

2.4.3 Mathematical modelling

The advantages of mathematical modelling are that they allow the researchers to create a model of organizations' or individuals' behavior. Once the model is established, it is relatively easy to change parameters and see how the outcomes change and thus, under which circumstances, certain outcomes are more likely to be found than others. By using a mathematical model, researchers can thus analyze what would happen in situations that are less likely to occur in real life or that would be difficult to observe. Disadvantages of the technique are that the researchers always need to make certain assumptions in order to build their models. Casadesus-Masanell and Zhu (2013), for example, make the assumption that firms do not face capacity constraints, an assumption that may not necessarily be very realistic when looking at new ventures. Secondly, the results from a mathematical model may be interesting and may provide deeper insights in the underlying relations between the different variables in the model, but may not necessarily reflect reality. Moreover, not

all situations can be transformed into a mathematical model. Mathematical modelling thus seems to only be an appropriate research technique in certain cases. The mathematical modelling studies in this review seem to mostly focus on the adoption of one business model versus another (Casadesus-Masanell & Zhu, 2010, 2013) or on competitive equilibrium situations (Casadesus-Masanell & Llanes, 2011).

Table 2.3 - Overview of business model literature: empirical perspective

	Article	**Sample: number of observations and setting**	**Industry focus**	**New ventures vs. established ventures/incumbents?**
1	Amit & Zott (2001)	59 public European and US-based e-business firms	No focus	No focus
2	Winter & Szulanski (2001)	1 superregional bank	No focus	Established ventures
3	Mangematin et al. (2003)	60 French biotech firms	No focus	Established ventures
4	Ding et al. (2005)	87 undergraduate business students	No focus	Not applicable
5	Tang (2005)	Focuses on impact of two laws on US and European music industry	No focus	No focus
6	Bonaccorsi et al. (2006)	146 Italian open source firms	No focus	New ventures
7	Zott & Amit (2007)	190 European and US-based e-business firms	No focus	No focus
8	Mason & Leek (2008)	1 business model of an offshore supply network in the aerospace industry, containing a core firm and two suppliers	Emerging industry	No focus
9	Zott & Amit (2008)	170 European or US-based e-business firms	No focus	No focus
10	Björkdahl (2009)	Three multi-national corporations	No focus	Established ventures
11	Doganova & Eyquem-Renault (2009)	1 academic spin-off	No focus	New ventures
12	Dewald & Bowen (2010)	126 Canadian real estate brokers	Established industry, but with disruptive innovation	Established ventures
13	George & Bock (2011)	151 managers of Indian firms attending an executive education program	No focus	No focus

	Article	Sample: number of observations and setting	Industry focus	New ventures vs. established ventures/incumbents?
14	Lazonick & Tulum (2011)	Focus on entire US biotech industry	No focus	No focus
15	Bock et al. (2012)	107 multinational firms where business model innovation was seen as the primary type of innovation effort	No focus	No focus
16	Halme et al. (2012)	2 multinational corporations that have business models targeted at alleviating poverty	No focus	Established ventures
17	Andries et al. (2013)	6 new ventures in various industries	No focus	New ventures
18	Desyllas & Sako (2013)	1 car insurance company	No focus	Established ventures
19	Suarez et al. (2013)	389 prepackaged software producers	No focus	Established ventures
20	Bohnsack et al. (2014)	Focus on entire electric vehicle industry	Emerging industry	Focus on both: new ventures vs. incumbents
21	Chandler et al. (2014)	166 pairs (high-growth and industry representative) of firms in 18 declining industries	No focus	No focus
22	Lehoux et al. (2014)	3 Canadian spin-offs active in health technology	No focus	New ventures
23	Mina et al. (2014)	788 UK-based companies	No focus	No focus
24	Brea-Solís et al. (2015)	1 retail corporation	No focus	Established ventures
25	Gerasymenko et al. (2015)	163 early-stage portfolio companies backed by French venture capital firms	No focus	New ventures
26	Kim & Min (2015)	131 publicly traded retail stores	No focus	Established ventures
27	Osiyevskyy & Dewald (2015)	241 Canadian real estate brokers	Established industry, but with disruptive innovation	Established ventures

In short, each method has its advantages and disadvantages. Some methods are only applicable in studying specific situations, e.g. mathematical modelling when studying the adoption of one model versus another. Other methods are more general and can be used to address a more broad range of research question, e.g. qualitative research is quite flexible and can be used to address a variety of research questions, going from investigating what business models really do (Doganova & Eyquem-Renault, 2009) over what firms' business model experimentation processes look like (Andries et al., 2013) to studying the different business models in an industry in general (Mangematin et al., 2003). In the next section, I discuss some gaps in the research on business models, both from a research theme and empirical perspective.

2.5 Gaps in research on business models

In this section, I will discuss some of the gaps in the business model literature, both from a research theme and empirical point of view. Each of these gaps will be addressed in at least one of the two empirical studies of this dissertation.

2.5.1 Research themes

In a previous section, I have highlighted the topic areas that have most often been studied in the business model literature. Despite an increase in the amount of studies that have focused on business models in recent years, there are still some topics that are underresearched or even have not been studied at all. A first such topic is the topic of business model change.

Business model change. From the 34 papers included in this review, three have more or less focused on the process of business model change. These studies have mostly touched upon the topic of business model change, and have shown how business model change can be important or how it can complement technology cross-fertilization (Björkdahl, 2009; Mason & Leek, 2008).

The only study that really focused on business model change or evolution processes, however, was the study by Andries et al. (2013). Using a case-study approach, they followed the business model evolution of six new ventures and investigated how organizational learning could explain firms' business model evolution processes. Despite their contribution of identifying two approaches of new ventures' business model evolution processes, much work still needs to be done to gain deeper insights in the process of business model change.

Current research has not focused on explaining which factors determine whether firms will engage their business models, and if and how these factors will have an influence on the frequency and degree of business model changes that firms undertake. Studies on organizational change processes typically focus on radical change (Hill & Rothaermel, 2003; Tushman & Anderson, 1986; Tushman & Romanelli, 1985), or on continuous improvement processes (e.g. Brown & Eisenhardt, 1997; Rindova & Kotha, 2001) and the performance implications of these change processes. There are only a limited number of studies (e.g. Furr, Cavarretta, & Garg, 2012) that aim to understand why firms engage in change behavior and what determines the extent of this change. Studying the factors that determine the degree and frequency of business model change could help gain deeper insights in the concept of a business model and could help understand firm's business model change processes. For this reason, the antecedents of business model change and the degree of business model change will be studied in the first empirical study of this dissertation.

Additionally, the impact of business model change processes on performance remains largely unexplored. Andries et al. (2013) investigated the impact of two different business model change processes on the short- and long-term performance of the new ventures, but only did this for their sample of six ventures. Quantitative studies with larger samples can provide more insights in this

relation between business model change and performance, which is why this will be addressed in the second empirical study of this dissertation.

Role of the ecosystem and alliance partners. A second topic on which few to no studies have focused is the role that firms' alliance partners and the business ecosystem in which the firm is positioned can have on a firm's business model. Alliances refer to "voluntary cooperative inter-firm agreements aimed at achieving competitive advantage for the partners" (Das & Teng, 2000, p. 33), while a business ecosystem can be seen as a group of companies that simultaneously create value by combining their skills and assets when individual companies are not capable of commercializing a product or service by relying on their own competences (Clarysse, Wright, Bruneel, & Mahajan, 2014). A firm's set of alliance partners can provide the firm with resources that are necessary for the firm to carry out its business model, and the alliances a firm maintains will also influence the degree to which the focal firm needs to monitor its partners, which is part of the governance component of a business model (Amit & Zott, 2001). Moreover, firms are increasingly part of ecosystems and their ability to create value depends on their complementors in the ecosystem (Kapoor & Lee, 2013). Effective strategies will thus depend on firms' abilities to accurately evaluate the risk for all parties involved in the ecosystem, ensuring opportunities for key complementors and deciding whether to be a leader or follower in the ecosystem (Adner, 2012; Adner & Kapoor, 2010; Priem, Butler, & Li, 2013). Like a business model, the concept of an ecosystem goes "beyond a focal firm's boundaries and adopts a more systemic perspective that emphasizes interdependencies and complementarities between a firm and third parties in order to understand how value is created" (Zott & Amit, 2013, p. 407). In order for a firm to take advantage of its alliance partners and its position in an ecosystem, its business model should be built in such a way that it matches the firm's position within its ecosystem and the firm's relationships with its

alliance partners. For example, if a firm needs certain resources to be able to produce its product or service, and there are only a limited number of suppliers who can provide this resource to the firm, the firm may consider producing this resource itself. On the other hand, if there are multiple downstream partners that can reliably produce the complementary goods, needed to use the product of the focal firm, the firm can rely on these downstream partners without having to produce the complementary goods themselves. This make-or-buy decision should be reflected in a firm's business model. Moreover, if a firm gains a distribution partner with a wide network of potential customers, the firm may decide to offer its products and services to a wider target market than originally planned, if the firm would not have had access to this distribution partner. As a result, firms' business models should be built with and understood within the context of the business ecosystem in which they are present.

Of the 34 studies included in this review, only Mason and Leek (2008) to some extent focused on the roles of partners in the business model development. They show how continuous business model changes are manifestations of inter-firm knowledge transfer and focus on network structure, inter-firm routines and knowledge forms. However, no studies have focused on the interplay between a firm's business model and the ecosystem in which it is present. It is thus clear that there has only been very limited research on the interplay between a firm's alliance partners and business models, or on the influence of a firm's business ecosystem on its business model, despite the link there seems to be between alliances and business models, as well as between a firm's ecosystem and its business model. The link between a firm's set of alliance partners, which can also be seen as the extent to which the firm engages in ecosystem development activities, and its business model will be addressed in the first empirical study of this dissertation, in which I propose alliances as antecedents of business model change.

2.5.2 Empirical perspective

In addition to the two research theme gaps in the business model literature, I also offer some more empirical gaps. In Table 2.3, which provides an overview of the empirical studies included in this review, I also summarized the characteristics of each study's sample. These characteristics are the type of industry on which the study focuses, i.e. an emerging versus an established industry and the type of ventures, i.e. new ventures versus established ventures.

Emerging industries. An emerging industry is an industry in which there is no dominant design, where the customers are unclear, the product attributes undefined and the industry value chain poorly established (Santos & Eisenhardt, 2009). Because of this high uncertainty, firms will more likely have to experiment with different strategies and business models before they find a business model that adequately tackles the uncertainty of emerging markets (Teece, 2010). As the industry itself is not yet established, firms active in emerging industries need not only legitimate their own actions, but also need to overcome the newness of the industry, which they can do by acting as institutional entrepreneurs that legitimate their ideas, business operations and ultimately the emerging industry (DiMaggio, 1991; Maguire, Hardy, & Lawrence, 2004; Rao, Morrill, & Zald, 2000).

As Table 2.3 shows, only four studies focus on a specific type of industry; two on an emerging industry, and two on an established industry which has experienced a disruptive innovation; the other studies do not focus on a specific type of industry. Choosing the right business model, however, is a key component of a successful strategy in an emerging market (McDonald & Eisenhardt, 2014). As a result, I argue that more studies should specifically focus on emerging industries and on how this may impact a firm's business model. In short, both the business model literature and the literature on emerging markets could benefit from gaining more insights in the

role of business models in emerging industries. As such, I will use the emerging mobile health industry as the research setting for the two empirical studies of this dissertation.

New ventures. Most of the studies included in this review either focus on established ventures (10 of 27) or have no specific focus on new versus established ventures and lump the two together (10 of 27). One study focuses on the differences in business models between new ventures and incumbents (Bohnsack et al., 2014) and only five studies exclusively focus on new ventures[2]. However, new ventures face challenges that established firms do not have to deal with. Due to liabilities of newness and smallness, new ventures have limited financial, technological and human resources and little power over other actors (Ambos & Birkinshaw, 2010). As a result, building a feasible business model, i.e. a business model that a firm can execute, given its levels of financial, technological and human resources, will be more challenging for these firms. Due to the increased difficulties that new ventures are faced with, their immediate goal will usually be more short-term, such as survival or the launch of a new product, than for established ventures that focus on long-term performance and profits (Ambos & Birkinshaw, 2010). Business models of new ventures should thus reflect their lack of credibility and their more short-term goals. Moreover, all existing ventures at one point in time were new, and getting insights into the business models of new ventures as they evolve into more mature organizations is important. To address this gap, I will focus on new ventures' business model change processes in the two empirical studies of this dissertation.

2.5.3 Combining the research theme and empirical gaps in the business model literature

[2] The study by Ding et al. (2005) uses undergraduate students as its sample, and thus does not use new or established ventures.

Figure 2.2 below combines the two research theme gaps and two empirical gaps in the business model literature. It shows that only three studies addressed the topic of business model change (Andries et al., 2013; Björkdahl, 2009; Mason & Leek, 2008), and only one partly addressed the link between business models and ecosystems or alliance partners (Mason & Leek, 2008). From an empirical perspective, only two studies explicitly focused on an emerging industry (Bohnsack et al., 2014; Mason & Leek, 2008) and six papers specifically focused on new ventures (Andries et al., 2013; Bohnsack et al., 2014; Bonaccorsi et al., 2006; Doganova & Eyquem-Renault, 2009; Gerasymenko et al., 2015; Lehoux et al., 2014). Only three papers addressed more than one gap (Andries et al., 2013; Bohnsack et al., 2014; Mason & Leek, 2008). It is thus clear that more work needs to be done in the business model literature and that the focus of this future work should lie in integrating some of the addressed gaps in the literature. This is precisely what I will do in this dissertation by executing two empirical studies of business models that target at least three of the mentioned gaps.

The first study, Chapter 4 of this dissertation, simultaneously addresses all four gaps (see also Figure 2.2). It focuses on how new ventures, active in an emerging industry, change their business models in response to their past business model experimentation processes and the new alliances that these ventures established. The second study, which is Chapter 5 in this dissertation, addresses three of the gaps. It focuses on how the business model changes of new ventures in emerging industries can have an impact on their performance. These studies will use a sample of new ventures in the mobile health industry, and will thus adopt a quantitative approach to test the hypotheses put forward in each study. Most of the studies in this review that addressed at least one of the four identified gaps in the business model literature, used a case-study approach. While cases are a useful and valid way of doing research when there is limited theory available

(Eisenhardt, 1989), the business model has sufficiently evolved and is now at the stage where it could benefit from more large scale, quantitative studies.

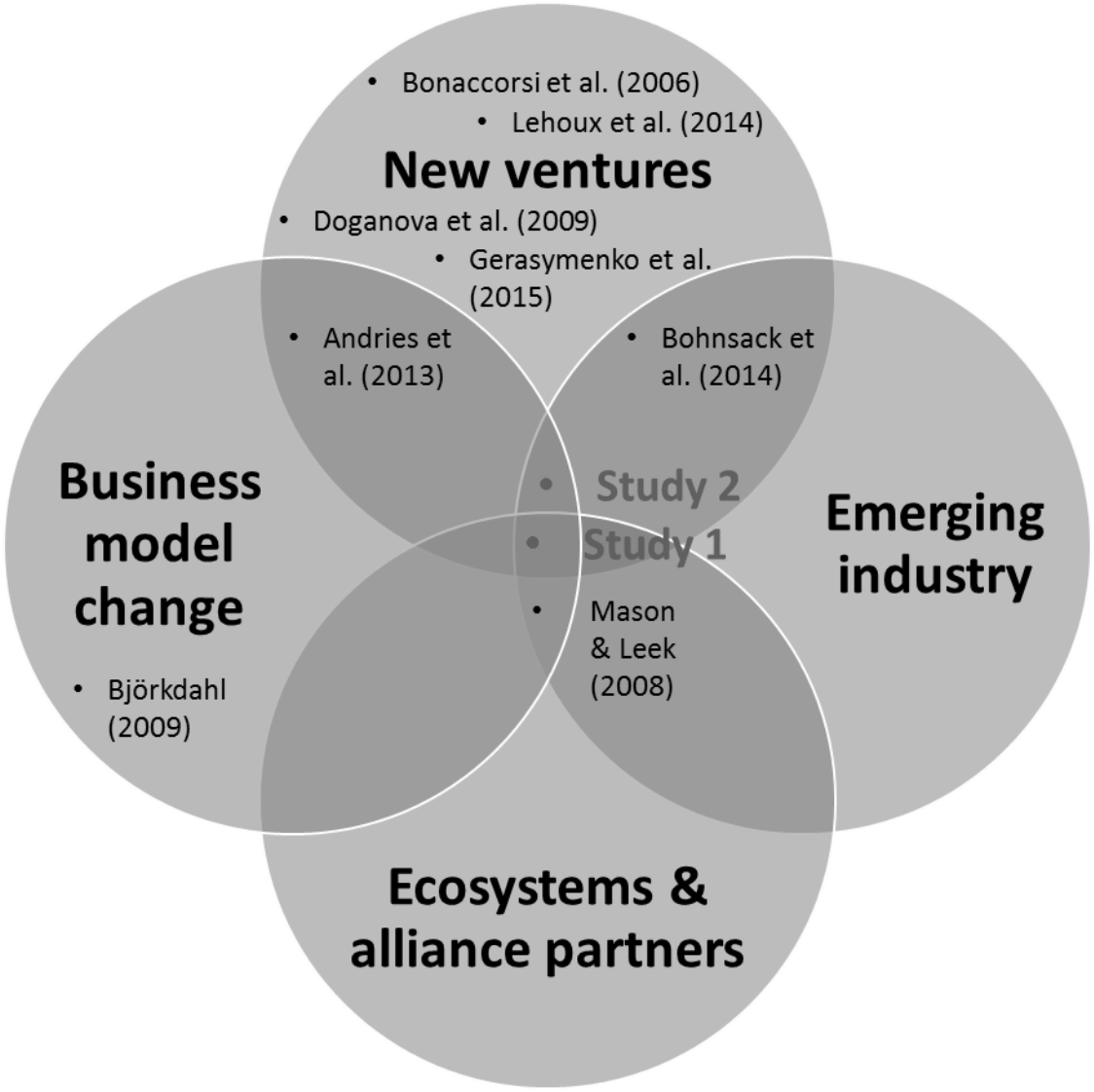


Figure 2.2 – Overview of gaps in business model research

2.6 Conclusion

In this chapter, I provided an overview of the business model literature, published in leading management and entrepreneurship journals. After identifying 72 studies, I retained 34 and grouped

them according to their shared research themes and empirical methods. I also provided four gaps in the research on business models, two based on the research topics that had been addressed in the previous literature and two that were identified from a more empirical point of view. Based on these gaps, I suggested that more work should focus on business model change processes and the interplay between a firm's business model and its alliance partners and ecosystem in which it is active. From an empirical point of view, more studies should focus on new ventures and on emerging industries.

I then positioned the two empirical studies of this dissertation in the existing business model literature and gaps, and showed how the first study (Chapter 4) will address all four future research avenues, while the second study (Chapter 5) will address three of the four gaps. Both studies will use a quantitative approach.

As mentioned before, the goal of this chapter was to provide an overview of the most common research themes and empirical methods used in the literature that could be used as a framework to position the two empirical business model studies of this dissertation in the literature. As a result, this study only included studies published in top academic journals, and focused on some of the most relevant future research avenues in the business model literature, without aiming to be exhaustive.

2.7 References

Adner, R. & Kapoor, R. 2010. Value creation in innovation ecosystems: how the structure of technological interdependence affects firm performance in new technology generations. ***Strategic management journal***, 31(3): 306-333.

Adner, R. 2012. ***The wide lens: A new strategy for innovation***: Penguin UK.

Ambos, T. C. & Birkinshaw, J. 2010. How do new ventures evolve? An inductive study of archetype changes in science-based ventures. ***Organization science***, 21(6): 1125-1140.

Amit, R. & Zott, C. 2001. Value creation in e-business. ***Strategic management journal***, 22(6-7): 493-520.

Andries, P., Debackere, K., & Van Looy, B. 2013. Simultaneous Experimentation as a Learning Strategy: Business Model Development Under Uncertainty. ***Strategic Entrepreneurship Journal***, 7(4): 288-310.

Bamford, C. E., Dean, T. J., & McDougall, P. P. 2000. An examination of the impact of initial founding conditions and decisions upon the performance of new bank start-ups. ***Journal of Business Venturing***, 15(3): 253-277.

Bergek, A., Berggren, C., Magnusson, T., & Hobday, M. 2013. Technological discontinuities and the challenge for incumbent firms: destruction, disruption or creative accumulation? ***Research Policy***, 42(6): 1210-1224.

Björkdahl, J. 2009. Technology cross-fertilization and the business model: The case of integrating ICTs in mechanical engineering products. ***Research Policy***, 38(9): 1468-1477.

Blank, S. 2013. Why the lean start-up changes everything. ***Harvard Business Review***, 91(5): 63-72.

Bock, A. J., Opsahl, T., George, G., & Gann, D. M. 2012. The Effects of Culture and Structure on Strategic Flexibility during Business Model Innovation. ***Journal of Management Studies***, 49(2): 279-305.

Bohnsack, R., Pinkse, J., & Kolk, A. 2014. Business models for sustainable technologies: Exploring business model evolution in the case of electric vehicles. ***Research Policy***, 43(2): 284-300.

Bonaccorsi, A., Giannangeli, S., & Rossi, C. 2006. Entry strategies under competing standards: Hybrid business models in the open source software industry. ***Management Science***, 52(7): 1085-1098.

Brea-Solis, H., Casadesus-Masanell, R., & Grifell-Tatje, E. 2015. Business Model Evaluation: Quantifying Walmart's Sources of Advantage. ***Strategic Entrepreneurship Journal***, 9(1): 12-33.

Casadesus-Masanell, R. & Zhu, F. 2010. Strategies to Fight Ad-Sponsored Rivals. ***Management Science***, 56(9): 1484-1499.

Casadesus-Masanell, R. & Llanes, G. 2011. Mixed Source. ***Management Science***, 57(7): 1212-1230.

Casadesus-Masanell, R. & Zhu, F. 2013. Business model innovation and competitive imitation: The case of sponsor-based business models. ***Strategic Management Journal***, 34(4): 464-482.

Casadesus-Masanell, R. & Hervas-Drane, A. 2015. Competing with Privacy. ***Management Science***, 61(1): 229-246.

Chandler, G. N., Broberg, J. C., & Allison, T. H. 2014. Customer Value Propositions in Declining Industries: Differences Between Industry Representative and High-growth Firms. ***Strategic Entrepreneurship Journal***, 8(3): 234-253.

Chesbrough, H. & Rosenbloom, R. S. 2002. The role of the business model in capturing value

from innovation: evidence from Xerox Corporation's technology spin-off companies. ***Industrial and Corporate Change***, 11(3): 529-555.
Clarysse, B., Wright, M., Bruneel, J., & Mahajan, A. 2014. Creating value in ecosystems: Crossing the chasm between knowledge and business ecosystems. ***Research Policy***, 43(7): 1164-1176.
Das, T. K. & Teng, B.-S. 2000. A resource-based theory of strategic alliances. ***Journal of management***, 26(1): 31-61.
Demil, B., Lecocq, X., Ricart, J. E., & Zott, C. 2015. Introduction to the SEJ Special Issue on Business Models: Business Models Within the Domain of Strategic Entrepreneurship. ***Strategic Entrepreneurship Journal***, 9(1): 1-11.
Desyllas, P. & Sako, M. 2013. Profiting from business model innovation: Evidence from Pay-As-You-Drive auto insurance. ***Research Policy***, 42(1): 101-116.
Dewald, J. & Bowen, F. 2010. Storm clouds and silver linings: Responding to disruptive innovations through cognitive resilience. ***Entrepreneurship Theory and Practice***, 34(1): 197-218.
DiMaggio, P. J. 1991. Constructing an organizational field as a professional project: US art museums, 1920-1940. ***The new institutionalism in organizational analysis***: 267-292.
Ding, M., Eliashberg, J., Huber, J., & Saini, R. 2005. Emotional bidders—An analytical and experimental examination of consumers' behavior in a priceline-like reverse auction. ***Management Science***, 51(3): 352-364.
Doganova, L. & Eyquem-Renault, M. 2009. What do business models do?: Innovation devices in technology entrepreneurship. ***Research Policy***, 38(10): 1559-1570.
Dye, R. A. 2004. Strategy selection and performance measurement choice when profit drivers are uncertain. ***Management Science***, 50(12): 1624-1637.
Eisenhardt, K. M. 1989. Building theories from case study research. ***Academy of Management Review***: 532-550.
Fiet, J. O. & Patel, P. C. 2008. Forgiving business models for new ventures. ***Entrepreneurship Theory and Practice***, 32(4): 749-761.
Furr, N. R., Cavarretta, F., & Garg, S. 2012. Who changes course? The role of domain knowledge and novel framing in making technology changes. ***Strategic Entrepreneurship Journal***, 6(3): 236-256.
George, G. & Bock, A. J. 2011. The business model in practice and its implications for entrepreneurship research. ***Entrepreneurship theory and practice***, 35(1): 83-111.
Gerasymenko, V., De Clercq, D., & Sapienza, H. J. 2015. Changing the Business Model: Effects of Venture Capital Firms and Outside CEOs on Portfolio Company Performance. ***Strategic Entrepreneurship Journal***.
Gruber, M., MacMillan, I. C., & Thompson, J. D. 2008. Look before you leap: Market opportunity identification in emerging technology firms. ***Management Science***, 54(9): 1652-1665.
Halme, M., Lindeman, S., & Linna, P. 2012. Innovation for Inclusive Business: Intrapreneurial Bricolage in Multinational Corporations. ***Journal of Management Studies***, 49(4): 743-784.
Hill, C. W. L. & Rothaermel, F. T. 2003. The performance of incumbent firms in the face of radical technological innovation. ***Academy of Management Review***, 28(2): 257-274.
Johnson, B. & Christensen, L. 2008. ***Educational research: Quantitative, qualitative, and mixed approaches***: Sage.

Johnson, M. W., Christensen, C. M., & Kagermann, H. 2008. Reinventing your business model. ***Harvard Business Review***, 86(12): 57-68.
Kapoor, R. & Lee, J. M. 2013. Coordinating and competing in ecosystems: How organizational forms shape new technology investments. ***Strategic management journal***, 34(3): 274-296.
Kim, S. K. & Min, S. 2015. Business Model Innovation Performance: When Does Adding a New Business Model Benefit an Incumbent? ***Strategic Entrepreneurship Journal***, 9(1): 34-57.
Lazonick, W. & Tulum, O. 2011. US biopharmaceutical finance and the sustainability of the biotech business model. ***Research Policy***, 40(9): 1170-1187.
Lehoux, P., Daudelin, G., Williams-Jones, B., Denis, J. L., & Longo, C. 2014. How do business model and health technology design influence each other? Insights from a longitudinal case study of three academic spin-offs. ***Research Policy***, 43(6): 1025-1038.
Litchman, M. 2006. ***Qualitative research in education: A user's guide***. Thousand Oaks, CA: Sage Publications.
Magretta, J. 2002. Why business models matter. ***Harvard Business Review***, 80(5): 86-92.
Maguire, S., Hardy, C., & Lawrence, T. B. 2004. Institutional entrepreneurship in emerging fields: HIV/aids treatment advocacy in Canada. ***Academy of Management Journal***, 47(5): 657-679.
Mangematin, V., Lemarié, S., Boissin, J.-P., Catherine, D., Corolleur, F., Coronini, R., & Trommetter, M. 2003. Development of SMEs and heterogeneity of trajectories: the case of biotechnology in France. ***Research Policy***, 32(4): 621-638.
Martins, L. L., Rindova, V. P., & Greenbaum, B. E. 2015. Unlocking the Hidden Value of Concepts: A Cognitive Approach to Business Model Innovation. ***Strategic Entrepreneurship Journal***, 9(1): 99-117.
Mason, K. J. & Leek, S. 2008. Learning to build a supply network: An exploration of dynamic business models. ***Journal of Management Studies***, 45(4): 774-799.
McDonald, R. & Eisenhardt, K. 2014. Competing in New Markets and the Search for a Viable Business Model. ***Working paper***.
Mina, A., Bascavusoglu-Moreau, E., & Hughes, A. 2014. Open service innovation and the firm's search for external knowledge. ***Research Policy***, 43(5): 853-866.
Osiyevskyy, O. & Dewald, J. 2015. Explorative versus Exploitative Business Model Change: The Cognitive Antecedents of Firm-Level Responses to Disruptive Innovation. ***Strategic Entrepreneurship Journal***.
Parker, G. G. & Van Alstyne, M. W. 2005. Two-sided network effects: A theory of information product design. ***Management Science***, 51(10): 1494-1504.
Priem, R. L., Butler, J. E., & Li, S. L. 2013. Toward Reimagining Strategy Research: Retrospection and Prospection on the 2011 AMR Decade Award Article ***Academy of Management Review***, 38(4): 471-489.
Rao, H., Morrill, C., & Zald, M. N. 2000. Power plays: How social movements and collective action create new organizational forms. ***Research in organizational behavior***, 22: 237-281.
Rindova, V. P. & Kotha, S. 2001. Continuous "morphing": Competing through dynamic capabilities, form, and function. ***Academy of Management Journal***, 44(6): 1263-1280.
Santos, F. M. & Eisenhardt, K. M. 2009. Constructing markets and shaping boundaries: Entrepreneurial power in nascent fields. ***Academy of Management Journal***, 52(4): 643-671.
Snihur, Y. 2013. Business Model Innovation: Exploring the Concept, its Antecedents and Consequences: Universidad de Navarra, IESE.

Sosna, M., Trevinyo-Rodríguez, R. N., & Velamuri, S. R. 2010. Business model innovation through trial-and-error learning: The Naturhouse case. ***Long range planning***, 43(2): 383-407.
Suarez, F. F., Cusumano, M. A., & Kahl, S. J. 2013. Services and the business models of product firms: An empirical analysis of the software industry. ***Management Science***, 59(2): 420-435.
Tang, P. 2005. Digital copyright and the "new" controversy: Is the law moulding technology and innovation? ***Research Policy***, 34(6): 852-871.
Teece, D. J. 2010. Business models, business strategy and innovation. ***Long range planning***, 43(2): 172-194.
Tushman, M. L. & Romanelli, E. 1985. Organizational evolution: A metamorphosis model of convergence and reorientation. In L. L. Cummings & B. M. Staw (Eds.), ***Research in organizational behavior***, Vol. 7: 171-222. Greenwich, CT: JAI Press.
Tushman, M. L. & Anderson, P. 1986. Technological discontinuities and organizational environments. ***Administrative Science Quarterly***, 31(3): 439-465.
Wang, Y. & Rajagopalan, N. 2014. Alliance Capabilities: Review and Research Agenda. ***Journal of Management***, http://jom.sagepub.com/content/early/2014/11/04/0149206314557157.
Winter, S. G. & Szulanski, G. 2001. Replication as strategy. ***Organization Science***, 12(6): 730-743.
Zott, C. & Amit, R. 2007. Business model design and the performance of entrepreneurial firms. ***Organization science***, 18(2): 181-199.
Zott, C. & Amit, R. 2008. The fit between product market strategy and business model: implications for firm performance. ***Strategic management journal***, 29(1): 1-26.
Zott, C., Amit, R., & Massa, L. 2011. The business model: recent developments and future research. ***Journal of Management***, 37(4): 1019-1042.
Zott, C. & Amit, R. 2013. The business model: A theoretically anchored robust construct for strategic analysis. ***Strategic Organization***, 11(4): 403-411.

3.RESEARCH SETTING & METHODOLOGY

3.RESEARCH SETTING & METHODOLOGY

In this chapter, I will first give more information on the mobile health industry, which is the setting used in this dissertation. Then I will provide an overview of the origins of the industry, as well as the players active in it, followed by a motivation of why this industry was chosen as the setting for this dissertation. Next, I will elaborate on how the sample for this study was chosen, as well as on how the data collection process was executed, followed by a short section on the operationalization of the main constructs used in this dissertation, some descriptive statistics on the sample and the different statistical methods used.

3.1 What is mobile health or mHealth?

Mobile health or mhealth is an emerging industry and refers to the use of mobile phones for health service and information. Istepanian, Pattichis, and Laxminarayan (2006) define it as "emerging mobile communications and network technologies for healthcare" (p. 3). Mobile health is considered as being narrower than e-health, which incorporates the use of all electronic devices and systems, whereas mHealth only considers mobile phone applications and is also distinct from telemedicine that uses more traditional desktop platforms (Istepanian et al., 2006).

Some examples of mobile health applications, products and services are weight loss and fitness apps for phones, electronic medication prescribing tools that can send prescriptions directly from a physician to a pharmacy, secure messaging systems between patients, doctors and hospitals, fall detection sensors that send signals to smartphones, medical implants that track certain conditions and send information to doctors, and blood pressure and glucose monitors for smartphones.

3.2 The emergence of the mobile health industry

Mobile health can be seen as being at the intersection of three separate, but related evolutions. These three evolutions are the development and increasing use of mobile Internet, the rise of smartphones and the increasing costs of the healthcare industry.

3.2.1 Mobile internet

Mobile Internet is defined as the use of the Internet via hand-held devices such as mobile phones or personal digital assistants (PDA) and is primarily different from stationary Internet in that it may be used in various contexts, where stationary Internet is mostly used in predetermined environments (Kim, Kim, Lee, Chae, & Choi, 2002).

Mobile Internet can be seen as an enabling technology for mHealth, meaning that mobile Internet was a prerequisite without which the mHealth industry would not have been able to take off. Over the last decade, significant advances in mobile Internet technology have taken place. Analog based first-generation wireless technology was developed in 1979 and was gradually replaced in the early 1990s with second generation (2G) digital radio technology which could accommodate text (Kim, Chan, & Gupta, 2007). Around 2001, third generation (3G) technology began to take off which primarily had faster connection speed and bandwidth, but also supported rich media such as video clips (Karjaluoto, 2007). In between 2G and 3G was 2.5G, an interim technology based on GPRS and EDGE that could accommodate limited graphics (Kim et al., 2007). Fourth generation services (4G) enable broadband wireless communication at home, at the office and on the move, and thus make the services provided by the Web and the Internet as well as a variety of other services such as multimedia and entertainment available to mobile users (Karjaluoto, 2007).

The increasing adoption rates of mobile Internet in the period 2005-2013, as well as the increases in technical abilities of mobile Internet over this period, provided a strong basis without which the mobile health industry could not have developed and grown.

3.2.2 Smartphones

Secondly, mobile health depends on the growing use of smartphones. According to one definition, smartphones are mobile devices with integrated wireless connectivity (Park & Chen, 2007; Suarez, Grodal, & Gotsopoulos, 2014) and thus differentiate themselves from regular cellphones by having WiFi capabilities. Another study defines smartphones as phones that have an advanced operating system such as Android OS, Blackberry OS, Linux, Mac OS, MS Windows Mobile, Palm OS and Symbian (Giachetti & Dagnino, 2013). Finally, while Suarez et al. (2014) originally defined a smartphone as a mobile device with WiFi capabilities, they state that the definition of a smartphone evolved over time such that the requirements for smartphones in 2012 also included touch screens. It is thus clear that the concept of smartphone, even though paramount in our daily lives, is not strictly defined and moreover, evolves over time.

Despite this lack of clear definition of what smartphones exactly are, the adoption of smartphones has significantly increased during the period of interest of this dissertation, i.e. 2005-2014. According to a report by Gartner (2006), the worldwide PDA and smartphone shipments totaled 3.65 million units in the first quarter of 2006, a 6.6 percent increase from the first quarter of 2005, while pure PDA shipments were slipping and shipments of smart mobile devices rose 55 percent year-on-year in the second quarter of 2006, indicating the increased popularity of smartphones and mobile phones (Park & Chen, 2007). In the third quarter of 2014, smartphone sales grew 20.3 percent to reach 301 million units, thereby surpassing the sales of regular mobile phones. Moreover, smartphones accounted for 66 percent of the total mobile phone market, and it is

estimated that by 2018, nine out of ten phones will be smartphones (Gartner, 2014). These numbers show that in the period 2005 till 2013, smartphone sales have almost multiplied a hundredfold, thereby supporting the increasing adoption of smartphones.

The increasing user uptake and technical abilities of smartphones have made the smartphone an important tool in our daily lives and have also contributed to the rise of the mobile health industry, as many mHealth applications are designed for smartphones.

3.2.3 Rising healthcare costs

Delivering affordable healthcare is one of the most pertinent challenges faced by any government. According to a report by AT Kearney and the GSM Association (Anscombe, 2011), the worldwide total healthcare spending exceeds $4.2 trillion, equaling about 10% of the GDP in OECD countries, and this amount is still increasing at an average of 5% every year.

The United States, for example, spends over 45% of the worldwide healthcare costs, while only having about 5% of the world population. Moreover, its population is aging, with an expected 20 percent of US population being over 65 by 2030, 8% up from the population over 65 in 2009 (MobiHealthNews, 2009). In addition to the aging population that creates a higher need for healthcare in the future, there is a trend towards a shortage of primary care physicians and nurses (MobiHealthNews, 2009). Moreover, due to economic downturns, most hospitals' budgets got cut, with about 71% of US hospitals admitting that budget allocations for IT would be lower in the next year than they were in the current year (MobiHealthNews, 2009). While the US' healthcare system may be facing more challenges than the healthcare systems in other countries, the trends mentioned above are not unique to the US and are taking place around the world.

It is thus clear something needs to change in order to improve healthcare systems around the world in alleviating some of the burdens they are facing. Increasingly, mobile health is being put forward

as this “something”. Not only can mobile health bring more people, even those living in remote areas, in contact with physicians and healthcare providers, mobile health can also be used to monitor individuals’ behaviors and lifestyles, as up to 40% of all chronic conditions are attributable to people’s own behavior (MobiHealthNews, 2009). Wireless health solutions can monitor, analyze, encourage and ultimately change behavior.

Rising healthcare costs and the search for ways in which these costs can be reduced have thus, together with the two previously mentioned evolutions of increasing use of mobile Internet and smartphones, lead to the emergence of the mobile health industry.

3.3 Overview of players in the mHealth industry

Although the most obvious type of players in the mobile health industry are those companies and organizations that create mHealth apps, products and services, there are a whole range of other players active in the mHealth industry without which mobile health products or services could not exist. Figure 3.1 below provides an overview of the different kinds of players in the mHealth industry. In the following, I will shortly discuss these different types of players as well as give some examples of their various roles in the mHealth industry, starting with the central mHealth organization.

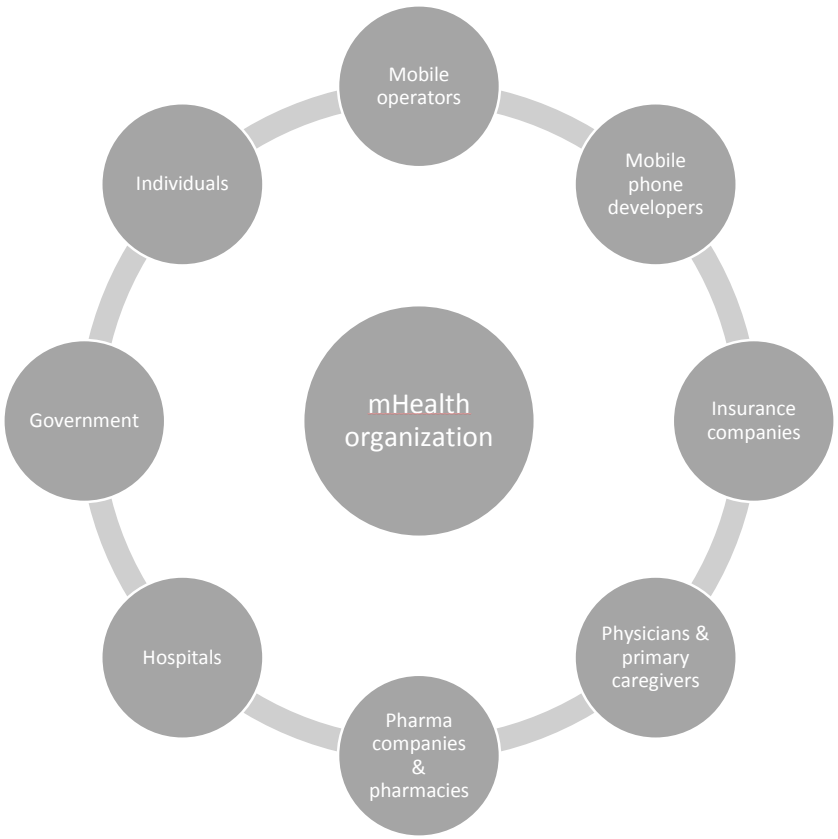


Figure 3.1 – Overview of players in the mobile health industry

mHealth organization. The first type of players in the mobile health industry are those companies and organizations that create, develop and market mHealth applications. These companies create applications such as remote monitoring tools for senior people (e.g Halo Monitoring, Wireless Medcare), medication reminder tools (e.g. CareSpeak, MedMinder), monitoring apps for people with chronic diseases (e.g. Entra Health Systems, MedApps), weight loss and fitness tools (e.g. Fitocracy, WorkSmart Labs) and online appointment systems (e.g. ZocDoc). These organizations are the topic of this dissertation, in which I focus on the business models of these types of organizations. However, indirectly, the other types of players will be part of my dissertation as well, as the focal mHealth companies' business models will need to account for the other players

in the industry and these companies will also often establish alliances with some of these other players within the industry.

I will now discuss the other types of players in the mHealth industry, starting with the mobile operators and subsequently the other types of players, following the outer ring of the figure above in a clockwise manner.

Mobile operators. Mobile operators such as Verizon Wireless or AT&T can be both active and passive players in the mobile health industry. On the one hand, due to the increasing use of mHealth applications, mobile operators can see increases in their customers' use of mobile data. On the other hand, mobile operators can also take a more active role. US carriers such as Verizon Wireless, AT&T and Sprint established partnerships or joint ventures with the aim of providing connectivity for, e.g. netbooks, eReaders and portable navigation devices (MobiHealthNews, 2009), thereby providing other devices with mobile Internet access using their network. Some mobile operators also invested in mHealth organizations. Verizon, for example, invested in NantHealth, a branch of NantWorks, in 2012. Other mHealth organizations established distribution partnerships with mobile operators, such as WellDoc and AT&T in 2010. Finally, signaling their dedication to the mHealth industry, some mobile operators such as Vodafone Group and Verizon, even launched their own healthcare focused business units (MobiHealthNews, 2009).

Mobile phone developers. Mobile phone developers are the third type of players in the mobile health industry. Even though this type of player may primarily have an indirect effect on the mobile health industry, developing smartphones with certain technical specifications is a necessary step in order for mHealth applications to be able to be developed. Moreover, Doro and Jitterbug, two

companies developing phones for elderly people, established various mHealth alliances and thus went further than merely creating a phone that supports mHealth applications. Doro, for example, established alliances with Entra Health Systems and Medixine to include mobile diabetes management and a medication reminder service in its mobile phones. Jitterbug acquired a mobile personal emergency response service start-up called MobiWatch, conducted pilots with several wireless health vendors and launched a Services Store with wireless health services (MobiHealthNews, 2009). Smartphone developers such as Apple and Nokia, also established alliances to strengthen their position in the mobile health industry. Apple partnered up with Epic Systems to include its iPhones in Epic System's EMR (Electronic Medical Record) service and Nokia invested in the mobile health start-up Vision+Fund and collaborated in an SMS-based diabetes prevention program in India. Moreover, especially in the non-regulated mHealth segment in which fitness and weight-loss apps are paramount, mobile phone developers, and especially the operating system developers, each have their own app stores in which mobile health apps are made available for purchase. All in all, it is clear that mobile phone developers, in addition to their phone manufacturing role in the mobile health industry, also try to strengthen their positions in this industry by including their products in service offerings or by adding mobile health features to their phones.

Insurance companies. Insurance companies are important players in the mHealth industry for a number of reasons. First of all, while the advantages of mHealth are clear, one of the most important issues in the industry is the question: "Who will pay for it?" Convincing insurance companies to reimburse their customers for the use of mHealth apps was an important challenge, even reported by some as being harder than getting FDA approval (MobiHealthNews, 2009). One

of the first companies that succeeded in getting reimbursement from insurance companies was CardioNet, whose Mobile Cardiovascular Telemetry Service qualified for Medicaid and Medicare reimbursement. After their initial qualification for reimbursement, however, some health insurance companies decided to cut the reimbursement rate for CardioNet's product, which lead to the company's stock tumbling and forced it to cut costs (MobiHealthNews, 2009). As a result of this struggle for getting and maintaining health insurance reimbursement, more wireless health start-ups tried pursuing a direct-to-consumer model or an indirect model in which employers would pay back the cost of the mHealth services of its employees to the mHealth start-ups (MobiHealthNews, 2009). It is thus clear that insurance companies have an important impact on the mobile health industry. A second way in which insurance companies are often influential in the mobile health industry is by being distribution partners for mHealth products and services. Hawaii Medical Services Assocation, for example, also known as the Blue Cross Blue Shield of Hawaii, was American Well's first distribution partner, thereby providing its insured members access to American Well's health marketplace service. Thirdly, insurance companies can be the target of an mHealth organization. Truveris, for example, offers health insurers, among others, unprecedented transparency into pharmaceutical benefit costs, design and procurement, which should help them verify claim accurancy and manage pharmacy spend.

Physicians and primary caregivers. Physicians and primary caregivers can take on a number of roles in the mHealth industry. First of all, physicians can be the target group of the mHealth companies. Organizations such as Modernizing Medicine and Phreesia focus on improving and alleviating some of the administrative burdens of physicians. Modernizing Medicine, for example, aims to help doctors save time by streamlining their handling of patient notes, bills and

prescriptions, and Phreesia digitizes the intake process of patients, by having patients fill out their medical histories on tablets. Moreover, physicians and primary caregivers can be parties involved in some mHealth applications, such as remote monitoring of patients and elderly people. MedApps, for example, creates a glucose monitoring tool that automatically sends the patient's data to his/her physician, who can keep track of the glucose levels. Halo Monitoring, on the other hand, is a fall detection system for elderly people that automatically notifies primary caregivers if a fall has been detected. Depending on the mHealth company's business model, physicians can be paying for the mHealth service (e.g. Modernizing Medicine) or can take on an active role without being the paying party (e.g. MedApps).

Pharmaceutical companies and pharmacies. Both pharmaceutical companies and pharmacies also play a role in the mHealth industry. Pharmaceutical companies such as AstraZeneca and Janssen Healthcare Innovations (a Johnson and Johnson subsidiary) created their own mobile health apps, such as an educational app on epidermal growth factor receptor gene-testing (AstraZeneca) and a medication adherence app (Janssen) (MobiHealthNews, 2011, 2014). Moreover, some pharmaceutical companies even go as far as acquiring a mobile health organization, such as Merck, who acquired Physicians Interactive (MobiHealthNews, 2014). Pharmacies, on the other hand, are frequently used as distribution channels for mHealth products, such as Adflow Health Networks, which placed blood pressure screening centers in various Rite Aid stores and WellDoc, which also established an alliance with Rite Aid such that Rite Aid employees would get access to WellDoc's virtual diabetes management coach. Moreover, pharmacies can also be involved more actively in some mHealth apps, such as ZappRx'

e-prescribing software, which alleviates the need for printed prescriptions and thus can automatically be sent from physicians to the pharmacies.

Hospitals. A large number of mHealth companies focus on products and services that are targeted at hospitals. Kit Check, for example, has created a product that simplifies the process of checking whether emergency kits and operating room's equipment kits are fully equipped and whether the products in these kits are not outdated. Another company, Voalte, created a platform that allows nurses to communicate with each other more efficiently and allows them to respond to individualized messages instead of general pager beeps. Healthagen's iTriage app provides patients with emergency room wait times and DocBookMD and TigerText facilitate secure messaging between hospital employees and physicians.

Government. The government plays a largely indirect role in the mobile health industry, even though some governments or government departments have participated or even started mobile health programs. Regional governments in Egypt and Saudi Arabia, for example, have partnered up with Qualcomm to set up country-wide mobile health systems. The US department of Veteran Affairs started a pilot project with mVisum to get critical medical information to a physician while on their way to a patient's bedside. The White House, finally, worked with a number of industry partners to launch a free text messaging service for low-income expectant mothers, called Text4Baby. However, the more important role of the government is checking whether medical devices and applications meet regulations. mHealth organizations that want to market their products on the European market need to get a CE conformity mark before they can do so. mHealth organizations in the US that work on data transfer between physicians, need to make sure their

products are FCC and HIPAA compliant, meaning that they must comply to the laws and requirements of the Federal Communications Commission and Health Insurance Portability and Accountability Act. Finally, the US' Food and Drug Administration department (FDA) can regulate any device that has a medical intended purpose (Thompson, 2010). Before 2013, there only existed a set of FDA guidelines on which mHealh products needed FDA approval and on how to achieve this approval, but no fixed set of rules. The most frequently used approach of getting FDA approval consisted in showing that the products seeking FDA approval were "substantially equivalent" to other products already on the market (Thompson, 2010). While the FDA rules issued in 2013 remained largely the same, they nevertheless provided mHealth organizations with more certainty and clarity regarding the FDA approval process (Thompson, 2013).

Individuals. The individuals are ultimately the most important player in the mHealth industry. Without patients, or people wanting to improve their health, there would be no mHealth industry. Individual users can be the ones paying for the mHealth products and services, as is virtually always the case in the non-regulated mHealth segment, but they can also be the end users without having to pay for the mHealth products and services, for example, when the health insurance companies reimburse the individual users. Moreover, even in those mHealth applications targeted at physicians, hospitals or pharmacies, the individual still has an important role: without patients, doctors or pharmacies would have no need for e-prescribing tools, and secure messaging between doctors and hospitals would also be irrelevant, since there would be no need to communicate. In short, regardless of the mHealth organization's business model, the individual has a very important role in the industry.

While there may be other players active in the mHealth industry, the previously listed ones can be considered as the most important ones in the mHealth industry. Some of them may not be unique to the mHealth industry such as hospitals or the government, but they nevertheless had an important role in shaping the mobile health industry and are therefore included in this overview. Moreover, it is the combination of all these types of players in a single industry that make the mobile health industry a unique research setting.

3.4 Types of mHealth organizations

Within the category of mHealth organizations, there are different types of companies. I distinguish between the types of companies based on the products and/or services they develop. Based on an interview with an industry expert[3], three types of mHealth companies were distinguished. The first type of mHealth companies focus on improving the information transfer, administrative processes and communication efficiency between patients, physicians and hospitals, and are labelled *administrative* mHealth companies. An example of an administrative mHealth company is mVisum, which developed a mobile application that allows physicians to securely receive, view and respond to patient data recorded at the point of care on their smartphones. mVisum also allows cardiologists to remotely diagnose heart attacks and allows them to communicate with people in the vicinity of the patient in order to better help him/her. The second type of mHealth companies, i.e. the *medical* companies are those companies that focus on delivering medical care. An example of a medical company is Vital Art & Science that developed a handheld application capable of diagnosing and monitoring age-related macular degeneration and diabetic retinopathy. The third type of mHealth companies are those companies that generally fall in the non-regulated market

[3] The interview was conducted by a colleague and was with the founder and director of the Center for Connected Health, who also is the co-founder of a mobile health start-up that is part of the sample of this study.

category and who create wellness, fitness and general health-related apps and are labelled the *fitness and wellness* segment. An example of a company in this segment is GymPact, which is an app that encourages people to work out and go to the gym.

Although FDA approval is not necessarily a requirement for companies in the administrative and medical segment, companies in the fitness and wellness segment will generally never apply for FDA approval and do not need it to be able to launch their products on the market.

3.5 Why the mHealth industry?

I chose the mHealth industry as the setting for this dissertation for a number of reasons. First of all, the mHealth industry emerged as a new field and is a blend including elements of a wide variety of other industry sectors. Therefore, a successful product commercialization in this market requires a network strategy that simultaneously integrates complementary assets from distinct categories, establishes market legitimacy and constantly refines the value proposition (Golicic & Sebastiao, 2011). Second, firms in this industry also need to deal with high environmental complexity and uncertainty. Each participant needs to work as an institutional entrepreneur to argue that their ideas or business operations should be legitimated (DiMaggio, 1991; Maguire, Hardy, & Lawrence, 2004; Rao, Morrill, & Zald, 2000). Finally, because products in the mHealth industry usually encompass a relatively large number of elements, participants in this new market also need to deal with product-level complexity. The high number of different players (see Figure 3.1 in section 3.3 of this chapter), along with their dependence on each other creates a highly interrelated setting, in which the players often have different goals, but nevertheless need to work together to be able to achieve their goals. It is the kind of setting in which business models will often be complex and in which alliances will be important.

Furthermore, the early stages of the mobile health industry were characterized by a lack of regulation, with the FDA, for example, only publishing its first report on guidelines and regulations for mobile health apps in 2013 (MobiHealthNews, 2014). Moreover, while investments in the mobile health industry, as well as the perceptions that mobile health is important have grown over the years, mobile health adoption rates have largely remained stagnant over the last couple of years (MobiHealthNews, 2014). This means that, almost a decade after being defined as "emerging" by Istepanian et al. (2006), the mobile health industry can still be considered as emerging, as it is still not clear how mHealth firms can achieve increasing user adoption and thus revenues. The mobile health industry is thus a clear example of an emerging industry, which is defined as "a business environment in an early stage of formation" (Santos & Eisenhardt, 2009, p.644) and characterized by an undefined industry structure (Eisenhardt, 1989; Rindova & Fombrun, 1999), unclear or missing product definitions (Hargadon & Douglas, 2001) and a lack of a dominant logic to guide actions (Kaplan & Tripsas, 2008).

For these reasons, the mHealth industry, with its wide range of applications and in which multiple parties have to cooperate to provide mHealth applications, is a particularly suitable emerging market in which to study business model change. Due to the interdependency between application providers, mobile phone developers, mobile Internet providers etc., the formation of alliances will be crucial for mHealth companies to be successful in the industry. Moreover, the business models needed for success in the industry will be quite complex and are likely to change when new players enter the industry. Andries, Debackere, and Van Looy (2013) have shown that the new ventures in their study changed their business models anywhere from once every two years to multiple times a year, until the dominant industry business model becomes clear. The current lack of dominant business model in the mobile health sector, combined with new ventures' tendencies to change

their business models and the high interdependency between players, makes the mobile health industry a particularly applicable setting for this study. While I expect the hypothesized relationships to hold in other more stable or less complex sectors, business model changes in such environments may be a less common event or might take longer to manifest.

Moreover, there are some advantages to using a single industry when conducting research. While the generalizability may be lower than when using multiple sectors, the use of a single sector allows the researcher a more clear interpretation of the events under study, without having potentially confounding industry effects that take place. This increases the internal validity (Osiyevskyy & Dewald, 2015). Moreover, it makes it more straightforward to create certain variables that are applicable to all firms in the sample. Variables such as FDA approval would be meaningless in samples that also include other industries, such as semiconductors or IT firms.

There is also one main disadvantage associated with using a single industry. This issue is the potential lack of generalizability: will the findings obtained in this setting be applicable and replicable in other settings as well? However, as mentioned before, the mHealth industry may be more likely to experience business model changes, thereby making it a more interesting industry to study, but it is not necessarily different from all other industries, which would mean that the results of this dissertation would not be generalizable to other industries. mHealth is an industry in which firms are embedded in an ecosystem, and in which alliances will be important because of the wide variety of different parties involved in the industry. This means that the success of mHealth firms may be partially dependent on their access to alliance partners, but this is not specific to the mHealth industry, and will also be the case in other industries in which ecosystems are important, such as in the semiconductor lithography equipment industry (Adner & Kapoor, 2010) or the solar photovoltaic industry (Kapoor & Furr, 2015).

Moreover, as will become more clear in the section on construct operationalization later in this chapter, none of the constructs used in this dissertation are specific to the mobile health industry. The business model variables were coded based on a scheme by Andries et al. (2013) that was used in various industries, such as E-commerce, biomedical medicine and machine systems. The alliance variables had previously been used in various industries such as biotechnology (Powell, Koput, & Smith-Doerr, 1996) and telecommunications (Phelps, 2010) and the performance variables used in Chapter 5 are general variables such as the number of new products developed and the survival of the firm that have been used in various settings as well. The remaining variables are firm-related characteristics such as management team size, number of patents held, VC-backed or not… that are also not industry-specific and can thus be used in various settings. As such, the findings of this dissertation should be generalizable to other sectors. However, of the 193 firms in this dissertation, only eight of them were not based in the US. This means that the findings of this dissertation will possibly not be generalizable to other countries. The findings of this dissertation can thus be seen as generalizable to other sectors, but possibly not to other countries in the world.

In the next section, I will now describe how the target population and sample were identified.

3.6 Population and sample

The target population of this study consists of new firms, active in the mobile health industry.

The sample for this dissertation was drawn from the annual MobiHealthNews reports from 2009 till 2013 and was complemented with a list of mHealth companies receiving investments, compiled by Rock Health. MobiHealthNews is an organization that focuses on providing news, research and information on the global mobile health industry. Their annual reports contain information on all alliance deals in the mHealth industry and cover various types of organizations, such as start-ups

incumbents, hospitals, and industry organizations. Rock Health is a company that provides mHealth start-ups with various forms of support, such as funding, access to potential partners, and office space.

As the mobile health industry is at the intersection of several industries, such as telecommunications, IT, and health research and services, to name a few, using industry reports that focus on the mobile health industry was the best choice to select firms active in the industry. A quick analysis shows that mHealth firms are categorized under a wide range of SIC (Standard Industrial Classification) codes, such as "Computer software development and applications" (73710300) for a company creating a heart measuring app, "Health insurance carriers" (63210102) for a company facilitating online doctor appointment scheduling, and "Medical research" (87330103) for a company that creates migraine and headache implants that are operating with a wireless remote. As a result, using SIC (or similar) codes to select mobile health organizations from an all-sector inclusive database such as Hoovers or Compustat was not feasible.

The sampling frame was defined by three criteria that jointly define new ventures in the mobile health industry and one more empirically-driven criterion.

First of all, firms had to be considered as new ventures. To this end, the sample only included firms that were founded between 2005 and 2013, meaning that they would at least be one year old at the time of the data collection and not more than eight years, which is the cut-off age used by Zahra (1996) for new ventures. Firms that were founded before 2005 were not selected in the initial sample; firms founded in 2014 were also not included, since business model change was analyzed on an annual basis, and these firms were too young to have undertaken a business model change according to the measurement method used. After an initial screening of firms, 239 companies

remained in the sample, of which seven later had to be dropped since it turned out they were founded before 2005 after all.

The second criterion was that firms had to be primarily active in the mobile health industry. This means that firms could either be active in the administrative, fitness and wellness or medical segment, as long as this was their primary set of activities. In other words, only firms that were labelled as an "mHealth organization" in Figure 3.1 (see above) were included in the sample. Hospitals, physicians, insurance companies and pharmaceutical companies involved in, but whose primary activity was not mobile health, were not included in the sample. This was done to create more homogeneity in the set of sample firms such that the sample firm's actions and choices with regards to their business models and business model changes were not inspired by other motives that may have been driven by these companies' primary activities. In the remaining sample of 232 firms, five companies did not meet the criterion of developing a mobile health application, product or service in any of the three segments as their primary activity.

The third criterion was that all firms had to be independent ventures, meaning that they were not the subsidiary of another firm. The business model structures of firms that are not independent may differ from firms that are independent. Moreover, the decisions to change a firm's business model can be driven by its parent company, rather than by the business unit itself, for those companies that are not independent. By only including independent firms in the sample, the sample is more homogeneous in terms of its ownership structure, and changes in the sample firms' business models will better reflect the companies' own decisions and strategies, rather than choices imposed from above. Eight firms did not meet this criterion, resulting in a sample size of 219 firms. Moreover, firms were only included in the sample as long as they remained active, independent firms. Firms that got acquired or that failed during the sample period, i.e. 2005-2014, were dropped

from the sample starting from the year after the one in which they got acquired or the year after the one in which they failed.

A fourth and final criterion that drove the sample selection was based on the fact that enough information had to be available on the firms. For twenty-one firms, not enough secondary information was available to meaningfully assess the firm's characteristics, business models and changes thereof. After dropping some other companies from the sample (see Figure 3.2 below for the reasons why), the final sample of this study resulted in 193 ventures, founded between 2005 and 2013, with their primary activities in the mobile health industry, and for which enough information was available to reliably code the company's characteristics.

The figure below shows how the final sample size of 193 was attained. The line displays the sample size starting from the 239 firms that were initially identified as part of the target sample after a first screening, to the final sample size of 193 firms. The bars show the number of firms that were dropped for the various reasons listed during a second screening round, with a lack of sufficient information being the most occurring reason for dropping a firm from the sample (21 firms were dropped for this reason).

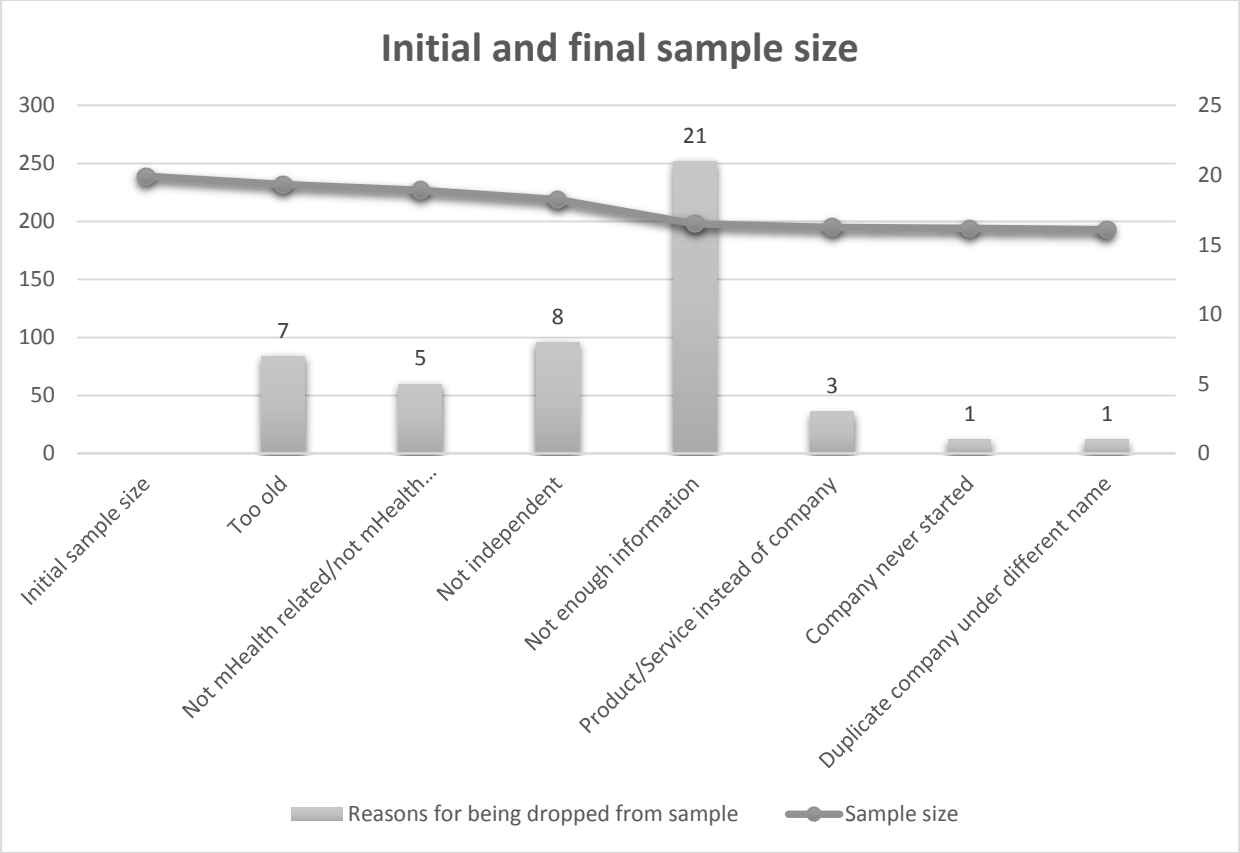


Figure 3.2 – Overview of initial and final sample size. The line should be read on the left axis and the bars on the axis on the right.

3.7 Data collection methodology

For the 193 sample firms, all data was collected based on secondary data sources. For each firm, data was collected on the firm's business model, alliances, management team, products on the market, sector, patents, FDA approval etc. This data was analyzed yearly for each firm, starting from the firm's founding year till (and including) the year 2014 or until the firm ceased to exist as an independent venture, due to being acquired or to the failure of the firm.

The different data sources used in this dissertation are:

- The companies' websites

- Press releases (collected from Factiva)
- The MobiHealthNews and Rock Health reports
- USPTO website for patent data
- US FDA website for FDA approval data
- LinkedIn and Zoominfo for founding and management team experience
- Hoovers and Crunchbase for additional company information

As no databases contain information on firms' business models or business model changes, this information was coded on the basis of the firms' press releases and websites, as well as on the basis of the MobiHealthNews industry reports. Press releases were downloaded from Factiva. To be able to analyze firms' business models from their inception till 2014 (or the year of their acquisition or failure, if this occurred before 2014), I used archived versions of the companies' websites using the WayBackMachine (http://www.waybackmachine.org). The press releases and archived versions of companies' websites were also used to collect data on changes in the firms' management teams, e.g. new hires or people leaving the company, as well as to gather data on the new product introductions and number of products on the markets during a given year.

Since the sample consists of new ventures, which may have a rather low number of alliances, alliance databases are not reliable for collecting alliance data. Rather, since these databases typically are more likely to include firms with more alliances, new firms are less likely to get included in these databases (Schilling, 2009). As a result, alliance data for the sample firms was collected on the basis of press releases, the companies' websites and industry reports (e.g. Lavie, 2007; Phelps, 2010). Additional data on the firms' patents was collected from the United States Patent and Trademark Office website (http://www.uspto.gov). Data on approval by the US Food and Drug Administration was collected from the department's website (http://www.fda.gov). Data

on the firm's founders and their experience was collected from LinkedIn (https://www.linkedin.com) and Zoominfo (http://www.zoominfo.com) and additional company information was collected from the Hoovers database by Dun & Bradstreet and CrunchBase (https://www.crunchbase.com) by TechCrunch.

As business model coding on the basis of secondary information is not always a clear-cut decision, a second coder coded all business models, in addition to the first coding that was done by me. The inter-rater agreement between the two coders for the relevant variables will be mentioned in the next section.

No data could be found for 20 companies' founding teams. In the second empirical study of this dissertation (Chapter 5), which focuses on the impact of business model changes on survival and performance of the ventures, founding team experience is included as a control variable. As a result, the effective sample size in this study is 173 companies instead of 193.

3.8 Operationalization of the constructs

In this section, the constructs used in the various studies are described, and the data sources that were used to calculate these variables are mentioned as well. For variables that were double-coded, the agreement between the two raters is mentioned.

3.8.1 Business model constructs

All business model constructs were developed on the basis of a categorization scheme by Andries et al. (2013), who use an adapted version of the original categorization scheme by Morris, Schindehutte, and Allen (2005). This categorization scheme consists of 26 items, grouped in 6 components that jointly make up a firm's business model. Some examples of items are whether the firm produces a product, service or both or whether the competitive strategy of the firm focuses

on low cost and efficiency or on an intimate customer relationship or experience. The six components are the company's offering, its target market, its internal capabilities, its competitive strategy, economic factors and personal/investor factors. The full list of items and their groupings into components can be found in Appendix A. Each firm's business model was coded for each year of the firm's existence as an independent unit till 2014 or until (and including) the year in which the firm was acquired or ceased its operations. As mentioned earlier, the data sources for the business model constructs were the archived versions of the companies' websites, along with press releases and the annual MobiHealthNews reports. All business model variables were coded by two independent raters. The agreement between both raters is provided per variable. For more information on how the inter-rater agreement was calculated and evaluated per variable, see Appendix B.

Business model change dummy. This variable measures whether or not a firm made a change to any of the 26 business model items of the Andries et al. (2013) scheme in a given year *t*, and is coded as 1 if the firm changed one or more of the items, and 0 if the firm did not make any changes to its business model during a given year. The average deviation (AD) index between the two raters for this variable was 0.12, which is lower than the cut-off average deviation of 0.23 that is suggested when using dichotomous variables (Burke & Dunlap, 2002). As a result, the inter-rater agreement for this variable was acceptable.

Number of business model items changed. This variable measures the number of business model items that were changed during a given year *t* and ranges from 0 to 26, with 0 indicating that the firm had not changed its business model during a certain year. A higher score on this variable indicates that a firm changed more business model items and is an indicator of more radical business model change. The average deviation index between the two raters for this variable was

0.27. Burke and Dunlap (2002) recommend a maximum average deviation index of *c/6*, with *c* being the number of response options that each rater has. As this scale ranges from 0 to 26, there are 27 potential response options, leading to the suggested cut-off value for the AD index of 4.5. As 0.27 is lower than this value, the agreement between both raters on this variable can be seen as acceptable.

Number of times business model was changed. This variable measures the cumulative number of times a firm had changed its business model up until (and including) year *t*. 0 indicates that firms had never changed their business models. The highest possible value for this variable equals the firm's age, indicating that a firm would have changed its business model during every year of its existence. The AD index for this variable is 0.30, which is an acceptable value for inter-rater agreement.

Time since last business model change. This variable measures the number of years since the firm has last changed its business model. The assumption is made that the initial business model that a firm establishes during the first year of its existence is a first business model change[4]. This is then used as a baseline for measuring the time since last change. For firms that never made a business model change, this variable will consequently equal the firm's age. For firms that have changed their business models, it measures the time since the firm had last changed its business model, with a 0 indicating that a firm had last changed its business model in the previous year. The AD index for this variable was 0.58, which again is an acceptable value for the inter-rater agreement.

[4] Note that this assumption that the initial business model equals a first business model change is only made for this variable, and not for the other business model constructs. The choice to make the initial business model equal a first business model change was merely made to set a baseline and to ensure that firms that had never changed their business models also got a meaningful value on this variable.

3.8.2 Alliance constructs

The data sources for the alliance constructs were press releases, the MobiHealthNews reports and the companies' websites and archived versions thereof.

Number of new alliances in year t. This variable measures the number of new alliances that a firm had established during that year. It lumps together the different types of alliances firms can establish, and merely measures the number of new alliances, of any type, that a firm established during year *t*.

Total number of alliances in year t. This variable measures the cumulative number of alliances a firm had established until, and including, year *t*, again not distinguishing between the different types of alliances firms may have established.

Alliance type. The next set of variables measure the number of alliances of a certain type that a firm established during year *t*. Based on the alliance types used by Powell et al. (1996), I included R&D ties, outside investor ties, clinical trials/evaluation ties, manufacturing ties, marketing/licensing ties, supply/distribution ties, investment/joint venture ties and complex ties. Complex ties occur when an alliance contains more than one of the previous mentioned activities. The categorization as a complex tie merely implies that an alliance had more than one component to it, but has no further meaning to it. As a result, complex ties were divided over the categories of ties of which they were made up. A tie categorized as a mix between supply/distribution and marketing/licensing would thus be divided as 0.5 in the supply/distribution category and 0.5 in the marketing/licensing category. As a result, the number of ties per category established during a year *t* can take on fractional values.

Alliance type portfolio diversity. This variable measures the diversity of the portfolio of newly established ties during year *t* that a firm established. It measures the diversity based on the categories mentioned above (i.e. R&D, outside investor, clinical trials/evaluation, manufacturing, marketing/licensing, supply/distribution and investment/joint venture ties). The alliance portfolio diversity in year *t* was measured using a modified Herfindahl index (Hall, 2002; Phelps, 2010):

$$\textit{Alliance type portfolio diversity}_{it} = \left[1 - \sum_{j=1}^{J}\left(\frac{N_{jit}}{N_{it}}\right)^2\right] * \frac{N_{it}}{N_{it}-1},$$

Where N_{it} is the number of alliances a firm has obtained in the previous years of its existence. N_{jit} is the total number of alliances of type *j* that a firm *i* has.

This variable can range from 0 to 1, with 1 reflecting maximum diversity. The assumption was made that firms who did not establish alliances or who only established one alliance during year *t* had a portfolio diversity of 0. This assumption was made since the modified Herfindahl index cannot be calculated if there are less than 2 observations. Due to having divided the complex ties over the categories of which they were made up, some Herfindahl scores were greater than 1. This value greater than 1 was only possible because of the fractional variables in the alliance type count data, which was the consequence of dividing the complex ties over the types they were made out of. I chose to recode these Herfindahl indices to 1, indicating that they equal the maximum alliance type portfolio diversity.

3.8.3 Time-fixed company-level constructs

The following variable was coded based on a number of different data sources, such as the companies' websites and archived versions thereof, press releases, LinkedIn and Zoominfo.

Founding team experience. Founding team experience was measured by three separate variables that measure the percentage of founders that had technical experience, market experience or start-up experience prior to founding the venture. Since the focus of this dissertation is on the mobile health industry, I translated technical experience into IT experience, and market experience into experience in the health industry. All information on the founding team's prior experience was obtained from the company's websites, LinkedIn and Zoominfo (e.g. Furr, Cavarretta, & Garg, 2012). I counted the number of founders that had experience in each of the three domains (IT, health, and previously started up a venture) and divided them by the total number of founders the venture had to calculate the three variables that indicate the percentage of founders with previous experience in the three relevant domains.

3.8.4 Time-varying company-level constructs

Data for the following variables was collected on the basis of press releases, archived versions of company websites, the MobiHealthNews and Rock Health reports and the USPTO and FDA websites.

Sector. Sector is a set of three dummy variables that indicate the mobile health industry sector in which firms are active (see also section 3.4 in this chapter). The three categories are *administrative*, *fitnesss and wellness* and *medical*. Even though most firms do not change sector, there are some exceptions and as a result, the sector dummies are measured annually to reflect potential changes in industry sector. Such changes often go hand in hand with business model changes.

Management team size. This variable measures the number of management team members a firm has during year *t*. This variable was measured on the basis of press releases and the firms' websites.

Products on market. Number of products on the market measures the number of products a firm has on the market, measured at the end of year *t.* Missing values were handled by extrapolating the values that were given and assuming a fixed growth rate in number of products on the market.

New product introductions. This variable was calculated based on the number of products on the market and measures the number of new products that were introduced in the market during year *t*. Product recalls were not included in this measurement.

Patents. Number of patents was measured based on data by the USPTO website and measures the number of patents approved during year *t*.

Number of FDA approvals. This variable measures whether a company has received FDA (Food and Drug Administration) approval for its services. Companies active in the non-regulated segment (i.e. fitness and wellness) generally do not have FDA approval. However, for those companies that fall in the other two categories, FDA approval may be a requirement to be able to market their product. Getting FDA approval could thus have an important impact on the number of products a firm has on the market, or on a firm's propensity to change its business model. This variable is calculated based on the US FDA website and measures the number of FDA approvals received during a given year *t*.

Number of product and company awards. This variable measures the number of product and company awards a company has received in a certain year *t*. Awards are social cues that assist decision making under uncertainty (Polidoro, 2013; Soh, Mahmood, & Mitchell, 2004). Firms receiving awards may thus see this as a validation of their product/service offerings and business models and may therefore be less inclined to change their business models. Moreover, product and company awards can increase the perceived value of a firm in the eyes of consumers, and as a

result, may increase the performance of the firm. Information on product and company awards was obtained from the firms' press releases.

Firm age. Firm age is calculated as the difference between the year under study and the firm's founding year.

VC-backed. VC-backed is a dummy variable that takes on the value 1 if a firm was venture capital (VC) backed during a given year *t* and 0 otherwise.

External funding raised cumulative. This variable reflects the cumulative amount of external funding, i.e. VC and angel funding, grants received, prize money won and bank debts received, in thousands of USD (or USD-equivalent) that a firm had access to during a given year *t*.

Company status. Company status measures a firm's status at the end of year *t*. This status can either be *active* if the firm still exists as an independent firm, *acquired* if the firm was acquired during year *t* and *failed* if the firm ceased its operations during year *t*. In the two last cases, year *t* would then be the last year of observation for that company, as tracking of the firm's activities and business model changes is only done for active and independent companies in the sample.

3.8.5 Time controls

Year dummies were included to control for period effects, such as differences in macroeconomic conditions or industry opportunities that may have occurred during the period of interest and that may have influenced a firm's propensity to change its business model, as well as the impact that these changes may have had on the venture's performance (Phelps, 2010).

3.9 Descriptive statistics of the sample

In this section, I provide some descriptive statistics of the sample, more in particular, on the sample firms' characteristics, and on the main dependent and independent variables used in this dissertation, i.e. the business model change variables and the firms' alliances.

3.9.1 Age of sample firms

As specified in the sample selection criteria, the age of the sample firms was limited to a minimum of one year and a maximum of eight years in 2013, resulting in a maximum firm age of nine years at the end of the sampling period, i.e. 2014. Table 3.1 below presents the age distribution of the sample firms. It shows that the majority of the sample firms were between three and five years old. The remaining firms were mostly older, with only 9% of firms being younger than three years at the end of the sampling period.

Table 3.1 – Age of sample firms

Age in years since founding	Number of firms	Percent of non-missing
1	1	0.5 %
2	16	8.5 %
3	32	16.5 %
4	39	20.2 %
5	31	16.0 %
6	22	11.7 %
7	17	9.0 %
8	19	9.6 %
9	16	8.5 %

Mean	Median	St. Dev.	Min	Max	Skewness	Kurtosis	N	Missing
5.13	5.00	2.09	1	9	0.35	-0.9	193	0

3.9.2 Industry segments of sample firms

As mentioned in section 3.4, I identified three segments within the mobile health industries. These segments were *administrative*, *fitness and wellness*, and *medical*. Table 3.2 below shows the distribution of sample firms over these three segments. The table shows that the majority of firms were active in the fitness and wellness segment, followed by the administrative segment and the medical segment.

Table 3.2 – Industry segments of sample firms

Industry segment	Number of firms	Percent of non-missing
Administrative	58	29.8 %
Fitness and wellness	100	51.6 %
Medical	35	18.1 %
N 193 Missing 0		

3.9.3 Location of sample firms

The table below provides an overview of the geographical distribution of the sample firms. Almost 96% of the sample firms were located in the USA, the remaining 4% were active in all other countries. Because of the strong geographical presence of US-based firms, the table also provides an overview of these firms' locations in the US.

Table 3.3 - Location of sample firms

Industry segment	Number of firms	Percent of non-missing
USA	185	95.7 %
CA, MA	90	46.8 %
IL, NJ, NY, TX	32	16.5 %
Other states	63	32.4 %
Other countries	8	4.3 %
N 193 Missing 0		

3.9.4 Company status of firms

The table below indicates the company status of each firm in its last year of observation. This is either 2014 for firms that did not fail or get acquired during the sampling period, or it equals the year in which the firm got acquired or failed. The table shows that about 80% of the sample firms were still active as independent ventures at the end of this study's sampling period, i.e. 2014. Of the remaining 20% of firms, 18% of firms got acquired and only 2% of firms failed.

Table 3.4 - Overview of company status of sample firms

Company status	Number of firms	Percent of non-missing
Active	154	79.8 %
Acquired	34	18.1 %
Failed	5	2.7 %
N 193 Missing 0		

3.9.5 Business model changes of sample firms

Table 3.5 below provides an overview of the number of firms that had changed their business models at least once during the period 2005-2014. It shows that the majority of firms did not undertake business model changes.

Table 3.5 - Overview of number of firms that changed their business models

Companies that changed business model			Number of firms			Percent of non-missing		
Yes			71			36.7 %		
No			122			63.3 %		
Mean	Median	St. Dev.	Min	Max	Skewness	Kurtosis	N	Missing
0.37	0.00	0.48	0	1	0.56	-1.71	193	0

Table 3.6 gives an overview of the number of times the sample firms changed their business models. As shown in the previous table, the majority of firms did not change their business models. For the remainder of firms, the table shows that the distribution of number of business model changes decreases, i.e. more firms undertook one business model change than two, but more firms undertook two business model changes than three, etc.

Table 3.6 - Overview of number of business model changes per company

Number of business model changes per company	Number of firms	Percent of non-missing
0	122	63.3 %
1	45	23.4 %
2	22	11.2 %
3	2	1.1 %
4	1	0.5 %
5	1	0.5 %

Mean	Median	St. Dev.	Min	Max	Skewness	Kurtosis	N	Missing
0.54	0.00	0.84	0	5	1.91	4.87	193	0

The table below, finally, provides an overview of the frequency with which each of the 26 business model items and six components of the Andries et al. (2013) scale were changed (relative to the total number of business model items that were changed). It shows that the business model component that was most frequently changed had to do with the target market of the firm, followed by the firm's offering and economic factors, internal capabilities, competitive strategy and personal investor factors. The individual item that was changed most frequently was the location of the target market, i.e. local, regional or international.

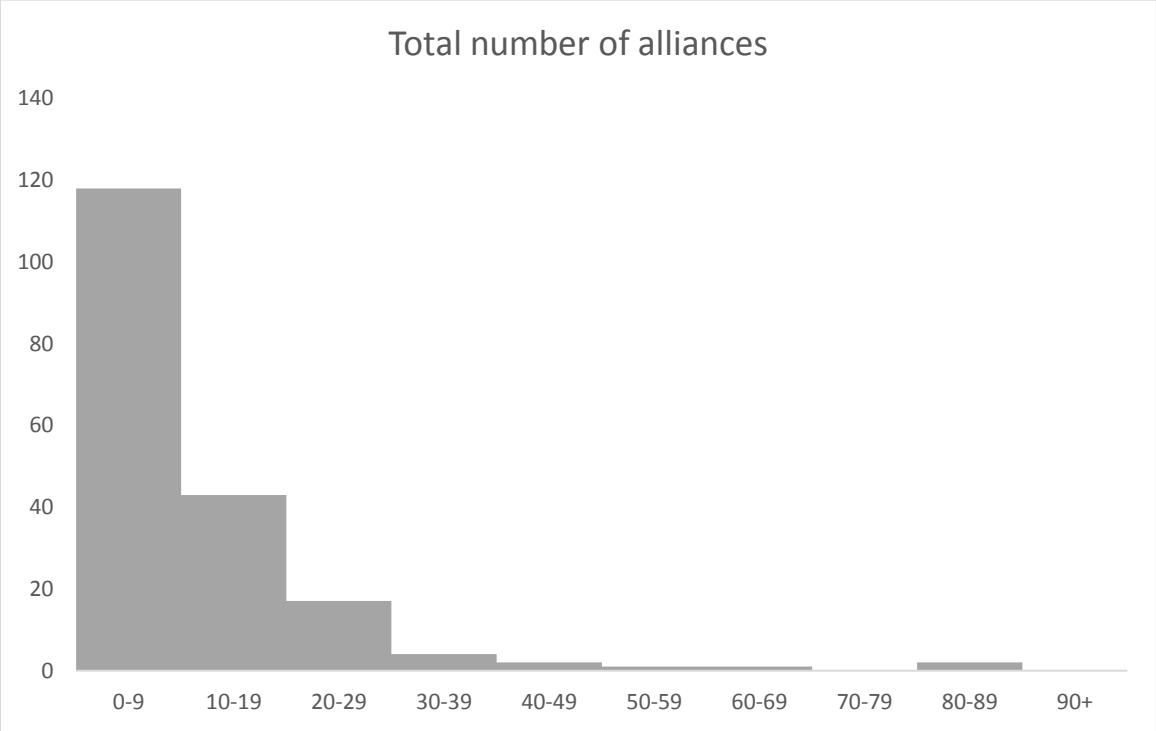
Table 3.7 - Overview of frequency of changes per business model item and component

Offering	**21%**
Product/service	3%
Standardized/some customization/high customization	5%
Internal manufacturing or service delivery/outsourcing/licensing/reselling/value-added reselling	1%
Direct distribution/indirect distribution	12%
Market	**35%**
Type of customer	7%
Local/regional/international	13%
Position of customer in the value chain	9%
Broad market/niche market	4%
Transactional/relational	3%
Internal capabilities	**20%**
Production/operating systems	2%
Selling/marketing	2%
Information management/mining/packaging	6%
Technology/R&D/creative or innovative capability/intellectual	2%
Financial transactions/arbitrage	0%
Supply chain management	3%
Networking/resource leveraging	5%
Competitive strategy	**11%**
Image of operational excellence/consistency/speed	2%
Product or service quality/selection/features/availability	4%
Innovation leadership	2%
Low cost/efficiency	2%
Intimate customer relationship / experience	1%
Economic factors	**21%**
Pricing and revenue sources	3%
Operating leverage	3%
Volumes	8%

Margins	6%
Personal investor factors	**1%**
Subsistence/income/growth/speculative model	1%

3.9.6 Alliances of sample firms

Figure 3.3 below provides an overview of the distribution of the total number of alliances held by the sample firms at the last year of observation. The average number of alliances held per firm is 10.78, with a median value of 7. Each firm had at least one alliance, while the maximum number of alliances was 86.



Mean	Median	St. Dev.	Min	Max	Skewness	Kurtosis	N	Missing
10.78	7.00	12.07	1	86	3.43	16.01	193	0

Figure 3.3 - Distribution of total number of alliances held by sample firms

Figure 3.4 below provides an overview of the distribution of the types of alliances held by all firms. It shows that, taking together all firms and observation years, the majority of alliances were outside investor ties, meaning that the sample firms received investments from a third party. The second most frequent type of ties were manufacturing ties, followed by supply/distribution, marketing/licensing, clinical trials/evaluation, investment/joint ventures and R&D ties.

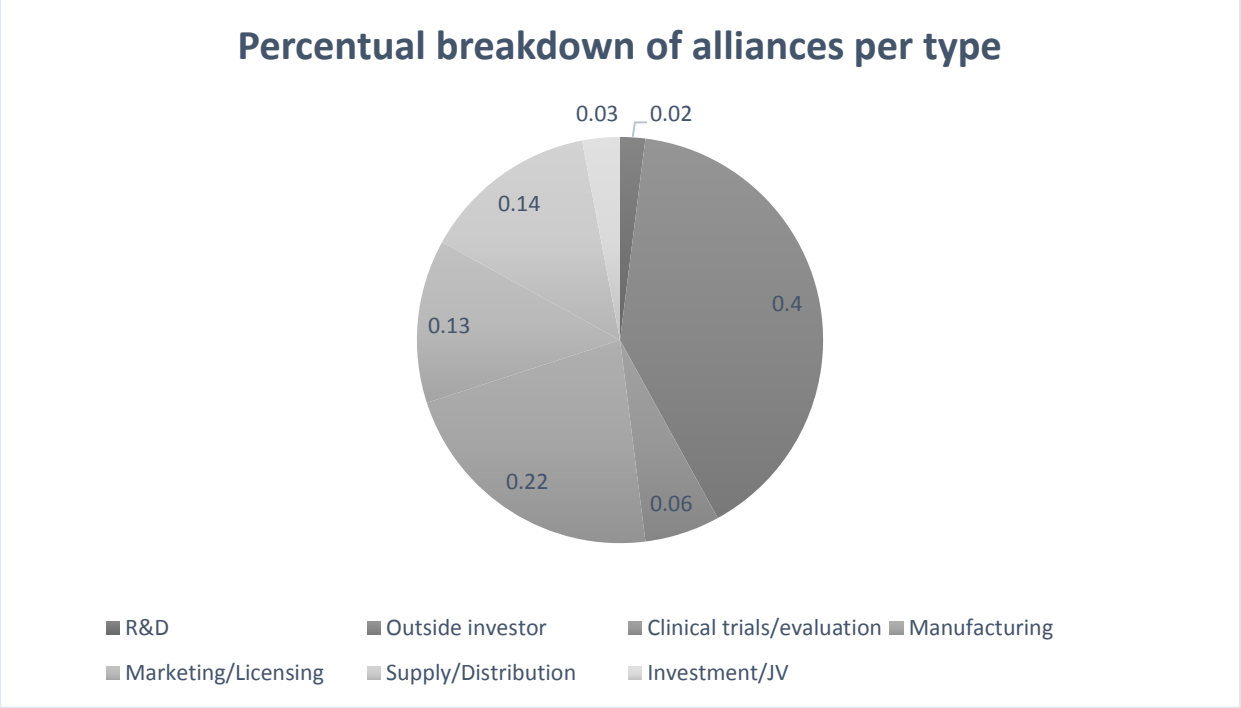


Figure 3.4 - Percentual breakdown of alliances per type

3.10 Statistical methods

In this section, I will provide some information on the main statistical techniques used in this dissertation.

3.10.1 Multiple linear regression

Multiple regression analysis aims at explaining the relationship between one dependent variable (DV) and several independent variables (IVs) (Tabachnick & Fidell, 2013). The regression equation takes the following form:

$$Y' = A + B_1X_1 + B_2X_2 + \ldots + B_kX_k\,,$$

where Y' is the predicted value of the DV, and A is the intercept, i.e. the value of Y when all the X values are zero. The X's represent the *k* IVs and the B's are the coefficients assigned to each of the IVs during regression. The goal is to arrive at a set of B values, i.e. regression coefficients, for the IVs that bring the predicted Y values from the equation (Y') as close as possible to the Y values obtained by measurement (Tabachnick & Fidell, 2013). The main assumptions for using multiple linear regression are normality of variables, homoscedasticity and independence of the independent variables.

Multicollinearity refers to a high correlation between variables, typically higher than 0.9 for bivariate correlations (Tabachnick & Fidell, 2013), which can lead to technical problems in estimating regression coefficients (Aiken & West, 1991). Multicollinearity can also be caused by multivariate correlations that are too high, making the detection of the multicollinearity more difficult. One way of measuring whether multicollinearity is present is by measuring the Variance Inflation Factor (VIF), for which values higher than 10 are pointing to multicollinearity, and values lower than 10 suggest that multicollinearity is not an issue (Kleinbaum, Kupper, & Muller, 1988). Multicollinearity often occurs when forming cross products of variables while including them in the analysis along with the original variables (Tabachnick & Fidell, 2013), a phenomenon that often occurs when including interaction effects. By centering the variables before creating the interaction term, i.e. subtracting the mean value of that variable of all observed values, the problem of multicollinearity when including interaction terms greatly decreases (Aiken & West, 1991).

In a regression analysis, the statistical significance of each regression coefficient B_k is tested with a t-test. The t-value associated with a coefficient indicates how many standard errors the coefficient is different from zero, while keeping the coefficients for other variables in the regression constant. The probability value p then indicates the significance of the test that this coefficient B_k is different from zero. Typically, coefficients with p-values below 0.05 are considered as significant, though some studies also use the value of 0.10.

The multiple coefficient of determination R^2 measures the proportion of the variation in the dependent variable that is explained by the combination of the independent variables in the multiple regression model (Diez, Barr, & Çetinkaya-Rundel, 2014). R^2 is biased, however, when more than one independent variable is included in the model. In this situation, it is better to use the adjusted R^2, which corrects for the number of independent variables that are included in a model, as well as the sample size (Diez et al., 2014). The adjusted R^2 is the most frequently used measure of the explanatory power of the multiple regression equation. The statistical significance of the overall model is indicated by the F test of the analysis of variance. The overall model is typically considered as significant when the significance level of the F test statistic is below 0.05.

3.10.2 Moderation/Interaction

In multiple regression analysis, the relationship of each predictor to the criterion is measured by the slope of the regression line of the criterion *Y* on the predictor; the regression coefficients are these slopes. In an equation that includes an interaction term, the interaction signifies that the regression of Y on X depends upon the specific value of Z at which the slope of Y on X is measured. There is a different line for the regression of Y on X at each and every value of Z. Because the regression of Y on X depends upon the value of Z, the effect of X is termed a conditional effect. The XZ interaction is symmetrical. The presence of XZ interaction in the

equation equivalently means that the effect of predictor Z is conditional on X; there is a different regression of Y on Z at each value of X (Aiken & West, 1991)

In practice, centered versions of the independent variables (i.e. the means of the variables are subtracted from their original, uncentered values) are entered in the first step of the regression analysis. In the next step, the product of the centered version of the independent variables will be entered in the regression analysis. If this effect is statistically significant, there is an interaction or moderating effect, meaning that the effect of X on Y is dependent on the specific value of Z for which the effect is examined.

3.10.3 Heckman selection model

A Heckman selection correction is made when there is a potential selection bias. This could be the case in the study in Chapter 4, for example, in which I investigate the antecedents of business model change and in a subsequent step, to what extent these antecedents have an impact on the degree of business model change. To have a meaningful interpretation of what drives the degree of business model change, firms that have never changed their business models are left out of this second step analysis. However, by only including firms in the analysis that changed their business models, there may be a selection bias, as these firms may significantly differ from firms that have never changed their business models. To control for this potential selection bias, a two-step Heckman selection model can be used (Heckman, 1979). In the first stage of the Heckman process, the entire sample of firms is included in a probit regression, in which the independent variables of interest are included, with the aim of predicting which firms will change their business models during the course of their existence, and which firms will never do this. This model should include at least one variable that is not included in the second step of the Heckman model. Based on this first-stage probit regression, an adjustment term, the inverse Mills ratio is calculated, which is the

monotone decreasing function of the probability that an observation has had a business model change. The inverse Mills ratio is then entered into the second regression model, in which we analyze how antecedents explain the degree of business model change a firm has undertaken (Heckman, 1979). The inverse Mills ratio thus corrects for the potential difference there may be between firms that have never changed their business models, and firms that have changed their business models, with regards to their values on the independent variables included in the first-step of the Heckman model.

3.10.4 Survival analysis

Survival analysis or event history analysis is a set of methods for modeling the length of time until the occurrence of some event (Hox, 2010). An important feature of survival data is that for some cases, the final event is not yet observed. This can be due to the fact that a subject left the study or because the study ended at a point in time before the event could be observed. These subjects, for which the survival time is unknown, are said to be censored. Simply excluding these observations from the model could lead to biased results. As a result, survival analysis aims to obtain unbiased estimates of the expected duration, including relevant predictor variables, and incorporating censored observations.

To do this, the survival analysis requires two separate elements: a variable with the time information and a variable that indicates the censoring status. The time variable provides the duration of time until the event, or until the last observation, and the censoring status indicates whether the last observation is censored or not. A survival analysis determines the cumulative proportion of subjects that survive to the beginning of that interval (the survival rate) and how many subjects who enter the interval experience the event before the midpoint of the interval (the

hazard rate). The probability of experiencing the event in interval *t* then equals the number of events in that interval divided by the number at risk.

One of the most frequent used methods of survival analysis is the Cox Proportional-Hazards model, which is also the model of survival analysis that is used in this dissertation. The hazards model reflects the probability of experiencing the event in time interval *t* given that the event was not previously experienced. It is a probability, and is thus bounded between zero and one. As a result, a log-linear function of predictors is used, rather than a linear model. Regression coefficients in the Cox Proportional-Hazards model give the relative effect of each covariate on the survivor function. Typical for the Cox Proportional-Hazards model is that it assumes that there is a proportionality of the hazard, meaning that the shapes of the survivor functions are the same for all cases (Tabachnick & Fidell, 2013).

3.10.5 Robust (Hubert/White - sandwich) standard errors

When the dependent variable of a model does not have a normal distribution, with normality of distribution being one of the requirements for using multiple linear regression, the parameter estimates produced by the maximum likelihood method are still consistent and asymptotically unbiased. However, the asymptotic standard errors are incorrect, and they cannot be trusted to produce accurate significance tests or confidence intervals and this problem does not always vanish when the samples get larger (Hox, 2010). When it is not desirable or possible to transform the outcome variable, another method to obtain better tests and intervals is to correct the asymptotic standard errors. One available correction method to do this is the Hubert/White or sandwich estimator.

If the residuals in a regression follow a normal distribution, both the "uncorrected" and the Hubert/White standard errors are consistent estimators of the covariance of the regression coefficients. However, when the residuals do not follow a normal distribution, the uncorrected standard errors are not correct. In other words, using Hubert/White or robust standard errors in analyses makes the inference less dependent on the assumption of normality, at the cost of sacrificing some statistical power (Hox, 2010). As a result, robust standard errors will be used throughout this dissertation where applicable. When Negative Binomial, Logistic or Probit models are used that account for non-normality of the dependent variable, robust standard errors will not be used.

3.11 References

Adner, R. & Kapoor, R. 2010. Value creation in innovation ecosystems: how the structure of technological interdependence affects firm performance in new technology generations. ***Strategic management journal***, 31(3): 306-333.

Aiken, L. S. & West, S. G. 1991. ***Multiple regression: Testing and interpreting interactions***: Sage.

Andries, P., Debackere, K., & Van Looy, B. 2013. Simultaneous Experimentation as a Learning Strategy: Business Model Development Under Uncertainty. ***Strategic Entrepreneurship Journal***, 7(4): 288-310.

Anscombe, J. 2011. Mobile Health - Who Pays?: GSMA, AT Kearney.

Burke, M. J. & Dunlap, W. P. 2002. Estimating interrater agreement with the average deviation index: A user's guide. ***Organizational Research Methods***, 5(2): 159-172.

Diez, D. M., Barr, C. D., & Çetinkaya-Rundel, M. 2014. OpenIntro Statistics, Second Edition ed.

DiMaggio, P. J. 1991. Constructing an organizational field as a professional project: US art museums, 1920-1940. ***The new institutionalism in organizational analysis***: 267-292.

Eisenhardt, K. M. 1989. Making fast strategic decisions in high-velocity environments. ***Academy of Management journal***, 32(3): 543-576.

Furr, N. R., Cavarretta, F., & Garg, S. 2012. Who changes course? The role of domain knowledge and novel framing in making technology changes. ***Strategic Entrepreneurship Journal***, 6(3): 236-256.

Gartner. 2006. Gartner says research in motion led worldwide PDA industry to 7 percents growth in first quarter of 2006.

Gartner. 2014. Gartner Says Sales of Smartphones Grew 20 Percent in Third Quarter of 2014. ***available at: www.gartner.com/newsroom/id/2944819 (accessed January 17 2015)***.

Giachetti, C. & Dagnino, G. B. 2013. Detecting the relationship between competitive intensity and firm product line length: Evidence from the worldwide mobile phone industry. ***Strategic Management Journal***.

Golicic, S. L. & Sebastiao, H. J. 2011. Supply Chain Strategy in Nascent Markets: The Role of Supply Chain Development in the Commercialization Process. ***Journal of Business Logistics***, 32(3): 254-273.

Hall, B. H. 2002. A note on the bias in the Herfindahl based on count data. In A. Jaffe & M. Trajtenberg (Eds.), ***Patents, citations and innovation***: 149-156. Cambridge, MA: MIT Press.

Hargadon, A. B. & Douglas, Y. 2001. When innovations meet institutions: Edison and the design of the electric light. ***Administrative Science Quarterly***, 46(3): 476-501.

Heckman, J. J. 1979. Sample Selection Bias as a Specification Error. ***Econometrica***, 47(1): 153-161.

Hox, J. 2010. ***Multilevel analysis: Techniques and applications***. New York, NY: Routledge.

Istepanian, R. S. H., Pattichis, C. S., & Laxminarayan, S. 2006. Ubiquitous M-health systems and the convergence towards 4G mobile technologies, ***M-Health***: 3-14: Springer.

Kaplan, S. & Tripsas, M. 2008. Thinking about technology: Applying a cognitive lens to technical change. ***Research Policy***, 37(5): 790-805.

Kapoor, R. & Furr, N. R. 2015. Complementarities and competition: Unpacking the drivers of entrants' technology choices in the solar photovoltaic industry. ***Strategic Management Journal***, 36(3): 416-436.

Karjaluoto, H. 2007. An investigation of third generation (3G) mobile technologies and services. ***Contemporary Management Research***, 2(2): 91.
Kim, H.-W., Chan, H. C., & Gupta, S. 2007. Value-based adoption of mobile internet: an empirical investigation. ***Decision Support Systems***, 43(1): 111-126.
Kim, H., Kim, J., Lee, Y., Chae, M., & Choi, Y. 2002. ***An empirical study of the use contexts and usability problems in mobile Internet***: Paper presented at the Hawaii International Conference on System Sciences.
Kleinbaum, D. G., Kupper, L. L., & Muller, K. E. 1988. ***Applied Regression Analysis and other Multivariate Methods*** (2nd ed.). Boston, MA: PWS-Kent.
Lavie, D. 2007. Alliance portfolios and firm performance: A study of value creation and appropriation in the US software industry. ***Strategic Management Journal***, 28(12): 1187-1212.
Maguire, S., Hardy, C., & Lawrence, T. B. 2004. Institutional entrepreneurship in emerging fields: HIV/aids treatment advocacy in Canada. ***Academy of Management Journal***, 47(5): 657-679.
MobiHealthNews. 2009. Wireless Health: State of the Industry 2009 Year End Report, ***MobiHealthNews***: MobiHealthNews.
MobiHealthNews. 2011. Mobile Health Q4/Year-end 2010, ***MobiHealthNews***: Chester Street Publishing.
MobiHealthNews. 2014. Digital Health Q4 2013/ Year-end State of the Industry, ***MobiHealthNews***: Chester Street Publishing.
Morris, M., Schindehutte, M., & Allen, J. 2005. The entrepreneur's business model: toward a unified perspective. ***Journal of Business Research***, 58(6): 726-735.
Osiyevskyy, O. & Dewald, J. 2015. Explorative versus Exploitative Business Model Change: The Cognitive Antecedents of Firm-Level Responses to Disruptive Innovation. ***Strategic Entrepreneurship Journal***.
Park, Y. & Chen, J. V. 2007. Acceptance and adoption of the innovative use of smartphone. ***Industrial Management & Data Systems***, 107(9): 1349-1365.
Phelps, C. C. 2010. A Longitudinal Study of the Influence of Alliance Network Structure and Composition on Firm Exploratory Innovation. ***Academy of Management Journal***, 53(4): 890-913.
Polidoro, F. 2013. The Competitive Implications of Certifications: The Effects of Scientific and Regulatory Certifications on Entries into New Technical Fields. ***Academy of Management Journal***, 56(2): 597-627.
Powell, W. W., Koput, K. W., & Smith-Doerr, L. 1996. Interorganizational collaboration and the locus of innovation: Networks of learning in biotechnology. ***Administrative Science Quarterly***, 41(1).
Rao, H., Morrill, C., & Zald, M. N. 2000. Power plays: How social movements and collective action create new organizational forms. ***Research in organizational behavior***, 22: 237-281.
Rindova, V. P. & Fombrun, C. J. 1999. Constructing competitive advantage: The role of firm-constituent interactions. ***Strategic management journal***, 20(8): 691-710.
Santos, F. M. & Eisenhardt, K. M. 2009. Constructing markets and shaping boundaries: Entrepreneurial power in nascent fields. ***Academy of Management Journal***, 52(4): 643-671.
Schilling, M. A. 2009. Understanding the alliance data. ***Strategic Management Journal***, 30(3): 233-260.
Soh, P.-H., Mahmood, I. P., & Mitchell, W. 2004. Dynamic inducements in R&D investment: Market signals and network locations. ***Academy of Management Journal***, 47(6): 907-917.

Suarez, F. F., Grodal, S., & Gotsopoulos, A. 2014. Perfect Timing? Dominant Category, Dominant Design, and the Window of Opportunity for Firm Entry. ***Strategic management journal***, http://dx.doi.org/10.1002/smj.2225.
Tabachnick, B. G. & Fidell, L. S. 2013. ***Using Multivariate Statistics*** (6 ed.). US: Pearson Education, Inc.
Thompson, B. M. 2010. FDA Regulation of Mobile Health - MobiHealthNews 2010 Report, ***MobiHealthNews***: Chester Street Publishing, Inc.
Thompson, B. M. 2013. FDA Regulation of Mobile Health (Second Edition), ***MobiHealthNews***: Chester Street Publishing, Inc.
Zahra, S. A. 1996. Technology strategy and new venture performance: A study of corporate-sponsored and independent biotechnology ventures* 1. ***Journal of Business Venturing***, 11(4): 289-321.

4.HOW ALLIANCES AND EXPERIMENTATION INFLUENCE BUSINESS MODEL CHANGES IN NEW VENTURES

WITH HELENA YLI-RENKO AND BART CLARYSSE

4. HOW ALLIANCES AND EXPERIMENTATION INFLUENCE BUSINESS MODEL CHANGES IN NEW VENTURES

Firms competing in emerging markets, i.e. markets characterized by a lack of dominant design in which the customers are unclear, the product attributes undefined and the industry value chain poorly established (Santos & Eisenhardt, 2009), can have a difficult time determining the right business model (Teece, 2010), which in this study is defined as "a coherent framework that takes technological characteristics and potentias as inputs and converts them through customers and markets into economic outputs" (Chesbrough & Rosenbloom, 2002, p. 532). In response to these uncertain and changing environments, a firm can change its business model, thereby reflecting the firm's increasing ability to use its resources and knowledge to create the best possible business model given the environment (Zott & Amit, 2008). A second situation in which business model change is particularly important, is in the case of new ventures. Andries, Debackere, and Van Looy (2013) argue that business model experimentation is important for new ventures, and Blank (2013) even goes as far as defining a start-up as a "temporary organization designed to search for a repeatable and scalable business model" (Blank, 2013, p. 5). Moreover, Sarasvathy (2001) argues that traditional planning methods do not suffice in rapidly changing and uncertain environments and that entrepreneurs should adopt an effectual approach, in which they remain flexible, take advantage of environmental contingencies as they arise and learn as they go (Perry, Chandler, & Markova, 2012).

While business model change thus has been put forward by several scholars as an important mechanism to alleviate some of the uncertainties regarding starting up a new venture in an uncertain industry, the business model literature does not offer a lot of insights into what these business model experimentation processes look like and which factors drive this business model change. One of the few studies that have investigated the process of business model change is a study by Andries et al. (2013), who identified that firms can adopt one of two mechanisms when changing their business models. The first mechanism, simultaneous experimentation, occurs when firms use multiple, related business models in an attempt to learn more about the environment before ultimately committing themselves to one business model. Firms choosing focused commitment, the second mechanism, will commit themselves to one business model and will only change it when ample time and evidence have shown that the previous business model was not effective, given the environment (Andries et al., 2013). The first way of changing a firm's business model is thus in the form of incremental "tweaks" to a firm's business model change, while the mechanism of focused commitment leads to business model change in the form of radical "pivots." Again, previous research has not adequately identified the processes of incremental and radical business model change, nor has it identified factors that could explain why some firms would engage in incremental tweaking of their business models, while others would choose for radical pivots. As a result, in this study, we analyze some of the antecedents of business model change and degree of business model change.

We do this by drawing on effectuation and organizational learning theories, as well as the literature on business model ecosystems and alliances. As mentioned before, a number of effectuation scholars have argued that new ventures confronted with uncertainty should not stick to the traditional ways of planning, which entails starting up with a specific goal and trying everything

to accomplish that goal. Rather, entrepreneurs should start their ventures with a more general goal in mind and then should use the resources and information at hand to attempt to satisfy that general goal (Perry et al., 2012; Sarasvathy, 2001). In doing so, they should adapt their goals, organizational form and ultimately their business model to the dynamic and uncertain environment in which they find themselves. This is related to the concept of experiential learning, in which firms engage in change behavior, and based on the success or failure of this change, either devote more resources to sustaining and implementing that change or to revising that change (Bingham & Davis, 2012; Haunschild & Sullivan, 2002; Van de Ven & Polley, 1992). As both effectuation and experiential learning are based on the notion of engaging in small changes and adapting based on the new information at hand (Perry et al., 2012; Sarasvathy, 2001) and on what was learned in the past (Bingham & Davis, 2012), we argue that business model experimentation, i.e. firm's business model changes in the past, will not only be a driver of business model change but will also be an antecedent of more incremental business model change.

Moreover, firms increasingly are part of a business ecosystem, in which their ability to create value depends on their complementors in the ecosystem (Kapoor & Lee, 2013). As emerging industries are characterized by a lack of a dominant design (Santos & Eisenhardt, 2009), firms will usually need to experiment with different business models to find the best one. Given its position in a business ecosystem, however, a firm's choice of organizational form and business model should take into account how the firm plans to connect with its ecosystem partners (Kapoor & Lee, 2013). In addition to being partners in an ecosystem, alliances can also provide firms with new information and resources (Ahuja, 2000). This information and resources can help firms, among other things, to build new capabilities (Hamel, 1991) or develop exploratory innovations (Phelps, 2010), or they can provide firms with the necessary tools to fine-tune their goals in response to the

environment (Sarasvathy, 2001), thereby leading to changes in the content of a firm's business model. Moreover, adding new alliance partners may also influence the structure of the firm within its business ecosystem, thereby leading to new ways of doing business with and subsequently governing of these partners. Furthermore, alliances and the information they bring with them, often lead to highly novel recombinations of knowledge (Fleming, 2001; Levinthal & March, 1981; Phelps, 2010). Consequently, we argue that alliances will not merely be drivers of business model change, but will tend to be drivers of more radical business model change.

By providing an answer to the following research question: "How do business model experimentation and alliance activities of new ventures in emerging industries affect their business model development processes?", our study contributes to several research streams. First of all, by proposing antecedents of business model change, we contribute to the business model literature. Second, our study goes one step further in investigating the impact of these antecedents on the concept of business model change by proposing that business model experimentation will lead to more incremental adjustments of a firm's business model while alliances will lead to more radical changes of a firm's business model. Third, by focusing on alliances as a driver of business model change, we do not only contribute to the literature on alliances, but also to the growing research stream focusing on business ecosystems (Adner & Kapoor, 2010; Kapoor & Lee, 2013). Fourth, by focusing on business model experimentation as a driver of business model change, our study shows that effectuation theory and experiential learning are also applicable in the context of new ventures' business model changes. Moreover, our study responds to a recent call for more research on the link between business model change and effectuation (Perry et al., 2012). Finally, by focusing on new ventures in emerging markets, this study also contributes to the entrepreneurship literature.

4.1 Theory and Hypotheses Development

3.2.1 Business model experimentation

Previous research has shown that young ventures, especially when confronted with uncertainty, should experiment with a range of business models (Andries et al., 2013; Gruber, MacMillan, & Thompson, 2008). New ventures that find themselves in these uncertain environments should start up with a general goal and then attempt to satisfy that general goal by using the resources at hand (Perry et al., 2012). Effectual entrepreneurs should thus remain flexible, take advantage of environmental contingencies as they arise and learn as they go (Perry et al., 2012), which will result in adapting their overall goals to interesting new resources and opportunities that may arise (Dew, Read, Sarasvathy, & Wiltbank, 2009).

As firms change their business models in response to these new opportunities, such as new markets or customer segments that can be accessed or targeted, they can often benefit from learning experiences. Experiential or trial-and-error learning is the process by which firms undertake a course of action whereby the consequences of that completed action will lead to changes in the firm's knowledge or action base (Bingham & Davis, 2012). From a behavioral theory of the firm perspective, this means that a firm's past activities and knowledge base will determine its future behaviors and actions (Cyert & March, 1963; Levitt & March, 1988). Changes that are deemed as unsuccessful will make the entrepreneurs intervene and prescribe new courses of action (Bingham & Davis, 2012; Van de Ven & Polley, 1992), thereby leading to more change. Moreover, by undertaking a certain action, such as business model change, firms put routines and structures in place that will support further change behavior, as well as increasing its absorptive capacity that will facilitate the future learning of new, related knowledge (Bruneel, Yli-Renko, & Clarysse,

2010; Cohen & Levinthal, 1990). As a result, we argue that business model experimentation, or the gradual process of changing the firm's business model, will increase the likelihood that firms will change their business models again in the future:

> ***$H1_a$: A new venture's past business model experimentation increases the likelihood of undertaking additional business model change.***

In addition to investigating the influence of business model experimentation on the likelihood of engaging in future business model change, our study also aims to predict to what extent business model experimentation will have an influence on the extent to which a firm's business model changes.

Theories on organizational change and learning posit that organizations can undertake two types of change behavior. Incremental or convergent change occurs when firms fine-tune their existing orientation or configuration (Greenwood & Hinings, 1996). With this type of change, firms will generally only change one single item of their configuration in each step of the learning process, thereby allowing them to verify whether this change improves performance (Andries et al., 2013; Levinthal, 1997). Radical change, on the other hand, is also described as "frame bending" change as it "involves the busting loose from an existing 'orientation'" (Greenwood & Hinings, 1996, p. 1024) and occurs when organizations simultaneously change multiple components of their configuration or orientation (Andries et al., 2013; Levinthal, 1997).

As we argued before, business model experimentation will reflect both the firm's learning from its environment and partners, as well as the learning that a firm does from its past actions and behaviors. We argue that firms that have engaged in more business model experimentation in the past, which means firms that have changed their business model more times in the past, will engage

in less radical [5] (and thus more incremental) business model change. As these firms have already changed their business models in the past, they fit the profile of engaging in multiple incremental changes whereby the firm learns from its past changes. Moreover, incremental change also better reflects the effectual approach of starting a new venture, meaning that the firm's founders will change the organization's goals, structure and business model based on information and opportunities as they arise, thereby suggesting a more gradual and organic way of business model change.

In short, we argue that business model experimentation will support a more incremental way of evolving a venture. This results into the following hypothesis:

> ***$H1_b$: For new ventures that change their business model, the higher the level of past business model experimentation, the less radical the business model change will be.***

3.2.2 Alliances as drivers of business model change

Firms increasingly are part of business ecosystems, in which their ability to create value depends on their complementors and partners in the ecosystem (Kapoor & Lee, 2013). For example, the success of an individual innovation will often depend on the extent to which complementors in the ecosystem can invest and adapt to accommodate the new innovation of the partner who invented the new innovation (Adner & Kapoor, 2010). Given its position in a business ecosystem, a firm's choice of organizational form should take into account how it plans to manage its ecosystem

[5] More radical business model change would mean that firms drastically change some or all of the business model items. An example could be a change from a B2C (business-to-consumer) business model to a B2B (business-to-business) business model, which should also have implications for the distribution channels the firm should use, the market needs the firm's offering should target etc. An example of more incremental business model change could be expanding the geographic region in which the firm is active. While internationalization typically creates some additional challenges for firms, such as not being familiar with the cultures of the new countries in which they are active, the product offering, market needs addressed and positioning in the market could remain the same.

partners (Kapoor & Lee, 2013). As the industry value chain and dominant design are not yet established in emerging markets (Santos & Eisenhardt, 2009), however, it is unlikely that firms' business ecosystems will remain static and will not change over time. Therefore, changes in a firm's business ecosystem should ultimately be reflected in the firm's business model, as a business model should take into account how a firm plans to manage its relationships with its key partners (Amit & Zott, 2001; Osterwalder & Pigneur, 2010).

In addition to merely being ecosystem partners of the firm, alliances with partners can also provide the focal firm with access to valuable resources (Ahuja, 2000; Gulati, 1995) and information (Burt, 1992) that were previously unavailable to the firm. Through its set of alliances, an organization can access the information and resources that then enable it to adapt to novel opportunities and challenges (Maurer & Ebers, 2006). For example, alliance partners may provide firms with the information needed to be able to target new customer segments or markets. As a result, new ventures can learn from the information and resources made available to them through their set of alliance partners, who can thereby influence them to change their business models. This notion is also found in effectuation theory, in which firms are considered to be the "residual of a process of constructing a network of partnerships and precommitments" (Sarasvathy, 2001, p. 254) in which its partners will help determine what goals the organization should pursue and which markets it will end up in (Dew et al., 2009). Alliances can thus influence a firm's business model in a number of ways.

However, there are also a number of arguments suggesting that too many new alliances make it less likely that a firm will engage in business model change. First of all, assuming that alliance partners provide the firm with resources that allow the firm to change its business model towards a better one, i.e. taking into account more information about the environment, the competitors etc.,

a continuing increase in the number of alliances can still give the firm access to more resources, but the goal and therefore the business model will become more fixed (Read, Dew, Sarasvathy, Song, & Wiltbank, 2009). In other words, an increasing set of new alliances will first make it more likely that the firm will change its goals and business models, but will ultimately make those goals more fixed, making subsequent business model change less likely.

Second, similar to how an increasing number of network ties may lead to redundant ties in social networks (Burt, 1992), it seems likely that the information and resources that new alliance partners bring in becomes less novel or even redundant. Moreover, while new organizations can start from a blank slate when learning, over time, tensions can arise between what the organization has learned in the past and the new learning that takes place (Crossan, Lane, & White, 1999). This can potentially lead to the fact that less learning takes place. As a result, too many new alliances can have as a consequence that firms stop learning from their alliance partners and stop taking advantage of the new information and resources they bring with them, thereby making it less likely that the firm will change its business model.

In short: we had two streams of arguments, the first of which suggesting that new alliances will make business model change more likely. These arguments were based on a firms' position in a business ecosystem and based on the new information and resources alliances can bring to firms. The second stream of arguments, however, suggested that firms' goals become more fixed as their number of new alliances increases and that this high number of alliances can also constrain firms in learning from their partners. Based on these two lines of thought, we suggest that the relation between the number of new alliances and the likelihood of engaging in business model change will be curvilinear, such that up to a certain point new alliances will increase the likelihood that firms

will engage in business model change, after which more new alliances will lead to a lower likelihood of business model change.

$H2_a$: The number of new alliances a firm establishes has an inverted U-shaped relationship with the firm's likelihood of engaging in business model change.

Similar to our hypothesis that business model experimentation leads to more incremental business model change ($H1_b$), we now argue that alliances will also have an influence on the extent to which a firm changes its business model.

As mentioned before, alliances can be an important mechanism for providing firms with access to new resources and information (Ahuja, 2000; Burt, 1992). Partners can bring in information about customer needs and market trends which may help firms prepare themselves for potential markets (Bruneel et al., 2010). In addition, the information and resources brought in by alliance partners can help firms build new capabilities (Hamel, 1991) and develop exploratory innovations (Phelps, 2010). Oftentimes, the alliances that are the most useful to the firm are those that bring in the most novel information or they are those alliances with partners that can bridge structural holes and provide the firm access to distant networks of firms (Tiwana, 2008). By establishing more alliances, firms may get access to these more distant regions of a network and as a result, may get access to the more novel information these partners typically bring with them. Following the logic that a firm's set of alliance partners can influence the business model change they undertake (Perry et al., 2012; Sarasvathy, 2001), we argue that firms with access to novel sources of information can have a larger impact on the firm's business model change than firms that do not have access to alliance partners and that can merely rely on their internal learning and experimentation processes with regards to business model change.

However, in a similar line of reasoning as was used for hypothesis 2a, there are again arguments that point to the fact that an increasing number of alliances can lead to less radical business model changes. As a result, we will here also hypothesize that there is an inverted U-shaped relation between number of new alliances and the degree to which the firm's business model will change.

A first argument in this line of thought is that an increasing number of alliances and/or alliance partners does not automatically lead to a wider pool of novel resources and information. As the firm's alliance portfolio grows, the firm may become more densely connected in a small cluster of companies that all have access to the same information (Burt, 1992). Therefore, the impact of establishing additional alliances on the extent of business model change may decrease.

Secondly, there are bounds to the degree of radical change that firms can undertake. March (1991) argues that there should be a balance between exploration, which in our study can be seen as experimenting with different business models, and exploitation, which translates into refining, implementing and executing business models. Firms that are engaging in too much exploration, which means that they engage in too many changes in their business models, risk having too many undeveloped new ideas and too little distinctive competence. We can therefore argue that an increasing number of new alliances cannot keep leading to more radical business model change without endangering the survival of the firm. For as a firm overhauls its entire business model, it may not have the right competences in place for executing the new business model. Moreover, while organizational identities can chance over time, it is suggested that organizations retain continuity in their essential features (Gagliardi, 1986; Gioia, Schultz, & Corley, 2000). Changes in a firm's business model that are too radical could create a mismatch between the firm's competences, business model and organizational identity.

A third and final reason why we hypothesize that an increasing number of alliances will not keep on leading to more radical change in a firm's business model is the fact that there may be limits to the absorptive capacity of a firm to learn. For example, there may be bottlenecks in the ability of organizations to absorb the feed forward of learning from the individual to the group and organization (Cohen & Levinthal, 1990; Crossan et al., 1999). However, unlike in a production process where work-in-process can be stored, ideas in the learning process cannot be stockpiled (Crossan et al., 1999). Therefore, an increasing number of new alliances will not keep leading to more organizational learning from a firm's alliance partners or taking advantage of the new resources and information these partners bring, and will hence not keep resulting in more radical business model change. Moreover, as an overflow of information or ideas can have a detrimental impact on the learning that takes place in an organization (Crossan & Sorrenti, 1997; Crossan et al., 1999), we argue that an increase in new alliances can lead to less learning and less exploitation from new opportunities taking place, thereby resulting in less radical business model change.

By combining our former arguments on the access to new information and resources that alliance partners can bring with them, thereby leading to novel recombinations of this knowledge and more radical changes in a firm's business model with our latter arguments on the decreasing and even negative impact that new alliances can have on organizational learning and radical business model change, we argue that:

> ***$H2_b$: For new ventures that changed their business model, there will be an inverted U-shaped relationship between the number of new alliances and the extent to which a firm's business model changes.***

3.2.3 Interaction effect of business model experimentation and alliances on business model change

We argued that business model experimentation would lead to more incremental business model change, as this form of business model change reflected a more organic way of changing and learning from these changes. On the other hand, however, it reflects the effectuation theory's argument that firms learn from their environment, their partners and change their business models according to new opportunities and information that arise (Andries et al., 2013; Dew et al., 2009). Consequently, one can expect that business model experimentation coinciding with the learning from a firm's alliance partners will be more radical than business model experimentation that does not coincide with new information and resources from a firm's alliance partners. This is because alliances can be seen as a source of learning about new environments that typically lead to novel information, which will make radical change more likely (Fleming, 2001; Levinthal & March, 1981; Phelps, 2010).

Therefore, we argue that a higher number of new alliances will attenuate the negative relation between business model experimentation and the degree to which a firm changes its business model, such that firms with a higher number of new alliance partners will engage in more radical business model change than firms with a lower number of alliance partners, given the venture's business model experimentation.

Accordingly, this results into our final hypothesis:

> ***H3: For new ventures that change their business model, the number of new alliances will mitigate the negative relationship between business model experimentation and the degree to which a firm changes its business model.***

Figure 4.1 below summarizes the hypothesized relations and effects.

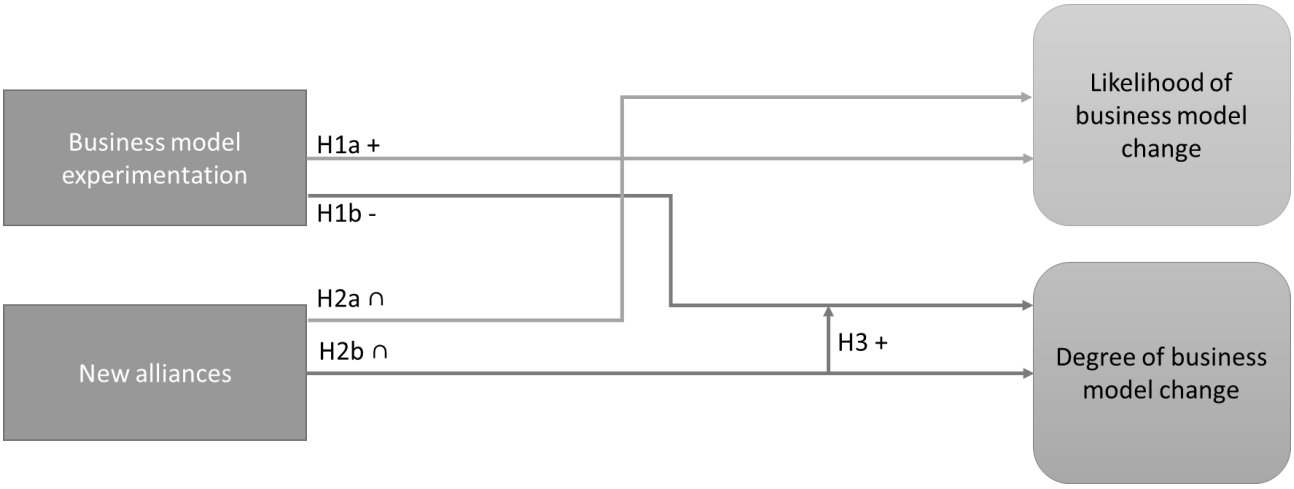


Figure 4.1 – Conceptual framework

4.2 Methods

4.2.1 Sample and data

As mentioned before, the research setting for this study is the mobile health industry. We refer to Chapter 3 for more information about this industry, as well as on how the sample was selected and the data collection was executed.

3.2.4 Measurement: Dependent Variables

The firm's business model was coded on the basis of a categorization scheme by Andries et al. (2013) which consists of 26 items that jointly make up a firm's business model. This categorization scheme is included in this dissertation as Appendix A. Each firm's business model was coded for each year of the firm's existence until (and including) 2014. Based on this annual data, we were able to identify whether firms changed any of the 26 items that jointly make up their business models.

Likelihood of business model change. This variable measures whether the sampled firms had changed their business models at least once during the period of their founding till their last year of existence as an independent venture or till 2013, whichever came first. Business model change was measured using the categorization scheme by Andries et al. (2013) (see also appendix A). For each year of the firm's existence, two independent raters coded each firm's business model. As soon as one of the 26 items that jointly make up a business model were changed, we coded this as a business model change for the firm. The average deviation (AD) index for this variable was 0.23, which is lower than the suggested threshold of 0.33 for dichotomous variables and thus shows a high degree of agreement between both raters (Burke & Dunlap, 2002)[6].

Degree of business model change. Degree of business model change was measured on the basis of the same categorization scheme by Andries et al. (2013). We counted the number of items that a firm had changed during a given year. The more items a firm changed (maximum possible value = 26), the more radical a firm's business model change is considered to be. Due to the skewed nature of this variable, we log-transformed it. The AD index was 0.27, which was below the suggested threshold, thereby again supporting the high agreement between both raters for this variable (Burke & Dunlap, 2002).

3.2.5 Measurement: Explanatory Variables

Business model experimentation in year t. Business model experimentation was conceptualized as the cumulative number of times that the firm had changed any of the 26 business model items of the Andries et al. (2013) scale until (and including) year *t*. We used the log-transformed version

[6] For more information on the average deviation (AD) index, its calculation, and the suggest thresholds, see appendix B.

of this variable due to skewness. The AD index for this variable was 0.30, which again proves its reliable coding by the two raters (Burke & Dunlap, 2002).

Number of new alliances in year t. Number of new alliances in year *t* measures the log of the number of new alliances that a firm had established during that year. Alliance information was gathered from secondary data sources such as the MobiHealthNews and Rock Health reports, as well as press releases and company websites.

3.2.6 Measurement: Control variables

To minimize alternative explanations and isolate the marginal effects of the explanatory variables, we also controlled for several variables whose influence on business model change might be confounded with the influence of the explanatory variables.

Sector controls. Sector is measured by a set of three dummy variables that indicate the mobile health industry sector in which firms are active. For a more detailed discussion of the three mHealth segments and examples of companies in each segment, please refer to Chapter 3, section 3.4. The three categories are *administrative, fitness and wellness*, and *medical* and were coded on the basis of each company's activities. *Fitness and wellness* was used as the reference category.

Number of patents. Previous research has shown that technological innovation can trigger changes in the company's operational and commercial activities, ultimately resulting in a changed business model (Calia, Guerrini, & Moura, 2007). To control for this potential effect, we collected patent data from the USPTO database. This variable was measured as the log of the number of patents that were approved for each firm in year *t*.

Number of products on the market. This variable was included for two reasons. First, having products on the market reflects a firm's stage of development. Moreover, if firms have products

on the market, they may receive customer feedback on their products. While positive feedback may encourage a firm to keep its current business model, negative customer feedback may lead to business model change. By conceptualizing this variable as the log of the number of products on the market in year *t*, it reflects both new product launches and product withdrawals. The data for this variable was collected on the basis of press releases and the companies' websites.

Number of FDA approvals in year t. This variable measures whether a company has received FDA (Food and Drug Administration) approval for its services. Companies active in the non-regulated segment (i.e. fitness and wellness) generally do not have FDA approval. However, for those companies that fall in the other two categories, FDA approval may be a requirement to be able to market their product. As getting FDA approval can be a tedious process, mHealth firms applying for such approval, may need to change their business model during the application process or, conversely, will not change their business model as long as the application process is running. Moreover, as FDA approval is an important source of legitimacy (Polidoro, 2013), FDA approval may cause firms to change their business models after getting the approval. FDA approval is measured as the log of the number of approvals the firm has received during year *t* and was collected using the US FDA website.

Number of product and company awards. In addition to FDA approval, which can be seen as a regulatory certification (Polidoro, 2013), we also include the log of the number of product and company awards a firm has received during year *t* in our analyses. Awards are social cues that assist decision making under uncertainty (Polidoro, 2013; Soh, Mahmood, & Mitchell, 2004). Consequently, early stage firms receiving awards may see this as a validation of their product/service offerings and business models and may therefore be less inclined to change their business models. Information on product awards was obtained from the firms' press releases.

Firm age. Older firms are generally less flexible than younger ones (Soh, 2003; Stinchcombe, 1965). Rigidities that develop over time can make it harder for the firm to undertake change, subsequently leading to a lower likelihood of business model change.

Management team size. This variable is measured as the log of the number of management team members a firm has during year *t*. Not only does it capture the potential impact of entries into/exits from a venture's management team on the firm's subsequent business model change, but it can also be considered as an indicator of firm size. Moreover, firms with larger management teams may have broader knowledge bases on which they can draw and there may be more opportunity for organizational learning to take place.

VC-backed. Previous research (e.g. Andries et al., 2013) has shown that it can be difficult to convince venture capital investors that the firm's business model needs to be reconfigured, as the VC may question whether the initial business model was wrong or whether potential problems that may have arisen were not just due to poor execution by the firm. On the other hand, Andries et al. (2013) also provide empirical evidence that investors may not mind business model reconfigurations, as this reflects a firm's adaptation to a changing and uncertain environment. To control for this potential impact of being VC-backed on business model change, we included a dummy variable, taking on the value 1 if the firm was backed by a venture capitalist in year *t* and 0 otherwise.

Alliance portfolio diversity. This variable controls for the diversity of a firm's alliance portfolio, reflecting its portfolio of collaborative activities. Alliance portfolios that are more diverse than others may lead to a broader spectrum of resources for the new venture, which may result in more radical business model change than firms whose alliance portfolios consist of only one type of tie. We adopted the alliance types used by Powell, Koput, and Smith-Doerr (1996) resulting in the

following types of alliances: R&D tie, outside investor, clinical trials/evaluation, manufacturing, marketing/licensing, supply/distribution, investment/joint venture and finally, complex ties, which occurs when an alliance contains more than one of the previous mentioned activities. We measured the alliance portfolio's diversity in year *t* using a modified Herfindahl index (Hall, 2002; Phelps, 2010):

$$\textit{Alliance type portfolio diversity}_{it} = \left[1 - \sum_{j=1}^{J}\left(\frac{N_{jit}}{N_{it}}\right)^2\right] * \frac{N_{it}}{N_{it}-1},$$

Where N_{it} is the number of alliances a firm has obtained in the previous years of its existence. N_{jit} is the total number of alliances of type *j* that a firm *i* has. This variable can range from 0 to 1, with 1 reflecting maximum diversity.

Year dummies. Year dummies were included to control for period effects, such as differences in macroeconomic conditions or industry opportunities that may have occurred during the period of interest and that may have influenced a firm's propensity to change its business model (Phelps, 2010).

3.2.7 Model specification and estimation

In this study, we are interested in analyzing the influence of our explanatory variables on both the likelihood of engaging in business model change and the extent to which a firm's business model changes. Firms that have changed their business models, however, may differ from firms that have not changed their business models. As a result, we used a two-step Heckman selection model (Heckman, 1979). In the first stage of the Heckman process, we studied the entire set of firms and investigated how our explanatory and control variables could predict which firms were more likely to engage in business model change. We also included some additional variables in this first stage

model that could potentially predict which firms were more likely to change their business models. These variables were the number of patents, product awards and FDA approvals a firm had received during year *t* and time dummies. We used a panel data probit model in the first step of our Heckman model. Based on this first-stage probit regression, we calculated an adjustment term, the inverse Mills ratio, which was then included as a control variable in the main second-step analyses (Heckman, 1979). In this second step, we then investigated the influence of our explanatory and control variables on the extent to which a firm's business model changes. Only including the firms that changed their business model in this second step, we used a panel data negative binomial model with fixed effects. Our choice for fixed effects was made on the basis of a Hausman test (Hausman, 1978) and resulted in a final sample of 390 firm-year observations[7]. To avoid reversed causality, we lagged all independent and control variables such that business model change in year *t+1* was predicted by the independent and control variables' values in year *t*.

4.3 Results

Descriptive statistics and the correlation matrix are presented in Table 4.1. Panel A of Table 4.1 includes the variables used in the first-stage probit model of the two-stage Heckman analysis and shows that in 13% of the observations, firms undertook a business model change. Since we are using panel data, with multiple observations per firm, this does not mean that only 13% of the firms undertook a business model change. In fact, 43% of our sample firms undertook at least one business model change in the period between 2005 and 2014. Panel A further shows that, on average, firms established 1.82 new alliances per year, were 2.48 years old and had 3.44 management team members. The average alliance portfolio diversity was 0.59 and in about 60%

[7] Three companies were dropped because they only had one observation per company, three other companies were dropped because of all zero outcomes.

of the firm-year observations, the firms were VC-backed. The average firm had almost 2 products on the market and received 0.3 patents and 0.13 product awards a year. Panel A further shows that in only 3% of the firm-year observations, firms received FDA approval and that 24% of the firms were active in the administrative mHealth segment, 36% in the medical segment while the remaining 40% of firms were active in the fitness and wellness segment.

The number of new alliances a firm establishes is significantly positively correlated with the likelihood of engaging in business model change. Management team size and alliance portfolio diversity are also significantly positively correlated to business model change. Finally, the number of product awards and FDA approvals a firm received are also significantly positively correlated to business model change.

The descriptive statistics and correlation matrix for the key variables used in the second stage of the Heckman analysis are presented in panel B of Table 4.1. This table shows that firms that have changed their business models, will ,on average, change 0.53 of the business model items per year. Table 4.1 further shows a rather high correlation between some of the independent and control variables (e.g. the correlation between alliance portfolio diversity and firm age is 0.45 in panel A and 0.4 in panel B). However, the mean VIFs obtained in both models were 3.34 and 1.64 and all individual VIFs were also lower than the rule-of-thumb cutoff of 10 (Ryan, 1997). Therefore, multicollinearity was not a problem in our analyses. All explanatory variables were centered prior to calculating the interaction or squared terms and prior to entering them into the model.

Table 4.1 – Descriptive statistics and correlation tables

Panel A – Heckman First-stage variables

	Mean	St. Dev.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.
1. Business model change (dummy)	0.13	0.34												
2. # new alliances	1.82	2.81	0.17**											
3. Business model experimentation	0.33	0.74	0.06	0.29**										
4. Firm age	2.48	2.14	0.06	0.17**	0.39**									
5. Management team size a	3.44	2.76	0.1**	0.1**	0.28**	0.19**								
6. Alliance portfolio diversity	0.59	0.34	0.08*	0.32**	0.3**	0.45**	0.18**							
7. VC-backed (dummy)	0.59	0.49	0.04	0.18**	0.11**	0.1**	0.19**	0.09**						
8. # products on market	1.95	3.4	0.04	0.07*	0.19**	0.26**	0.08**	0.19**	0.07*					
9. # patents	0.32	2.77	0.02	0.08**	0.18**	0.08**	0.10**	0.11**	0.05	0.23**				
10. # product awards	0.13	0.43	0.09*	0.23**	0.21**	0.13**	0.14**	0.19**	0.06	0.03	0.02			
11. # FDA approvals	0.03	0.16	0.13**	0.05	-0.03	0.09**	0.03	0.10**	-0.06*	0	0	0.13**		
12. Sector: Administrative	0.24	0.43	0.01	-0.03	-0.05	-0.05	-0.06*	-0.04	0.12**	-0.07*	-0.08*	-0.02	-0.07*	
13. Sector: Medical	0.36	0.48	-0.03	0	-0.02	0.13**	0.12**	0.11**	-0.16**	-0.05	0.14**	0.06	0.19**	-0.42**

a Raw variable used for mean and st.dev., log version used for correlations

n(companies) = 193, n(observations) = 794; * p<0.05, ** p<0.01

The dependent variable is measured for year t+1; the independent variables for t.

Panel B – Heckman Second-stage variables

	Mean	St. Dev.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
1. # business model component changes	0.53	1.27										
2. # new alliances	2.37	3.37	0.03									
3. Business model experimentation	0.67	0.94	-0.09	0.27**								
4. Firm age	2.78	2.18	-0.05	0.19**	0.54**							
5. Management team size a	3.77	3.54	0.09	0.10*	0.35**	0.19**						
6. Alliance portfolio diversity	0.63	0.3	-0.01	0.33**	0.40**	0.45**	0.22**					
7. VC-backed (dummy)	0.6	0.49	-0.05	0.14**	0.15**	0.10*	0.23**	0.03				
8. # products on market	2.19	2.42	-0.04	0.08	0.36**	0.27**	0.18**	0.28**	0.13**			
9. inverse Mills ratio	1.85	0.94	-0.13**	-0.29**	-0.11*	-0.15**	-0.23**	-0.20**	-0.04	0.04		
10. Sector: Administrative	0.34	0.48	-0.03	-0.03	-0.04	-0.10	-0.04	-0.05	0.14**	-0.03	-0.03	
11. Sector: Medical	0.26	0.44	-0.09	0.01	-0.07	0.11*	0.09*	0.12*	-0.13**	0.02	0.08	-0.43**

a Raw variable used for mean and st.dev., log version used for correlations

n(companies) = 83, n(observations) = 402; * p<0.05, ** p<0.01

The dependent variable is measured for year t+1; the independent variables for t.

3.3.1 First-stage Business Model Change Likelihood Estimates

Table 4.2 presents the results of the first-stage Heckman selection model, which was a panel data probit regression of the likelihood of engaging in business model change behavior. The dependent variable was the dummy variable of whether or not the firm engaged in business model change behavior in the period between its founding year (the oldest firms in the sample were founded in 2005) and 2014. Model 1, the baseline model, included the control variables and shows that firms with larger management teams will be significantly more likely to engage in business model change. Moreover, a higher number of FDA approvals leads to a higher likelihood of engaging in business model change, and firms active in the medical segment are significantly less likely to engage in business model change than firms active in the fitness and wellness segment.

The two explanatory variables, business model experimentation and number of new alliances were added in model 2. The results show that business model experimentation does not significantly increase a firm's likelihood of engaging in business model change. As a result, hypothesis 1a was rejected. A higher number of alliances, however, has a significant positive impact on the likelihood of engaging in business model change. In the third model, the squared term of number of new alliances was added. As this coefficient has a significant negative impact on the likelihood of engaging in business model change, we find support for the inverted U-shaped relation that we hypothesized between the number of new alliances and the likelihood of changing the firm's business model (H2a). This means that the likelihood of engaging in business model change will first increase as a firm establishes more alliances, and will decrease again as the number of new alliances a firm establishes keeps on increasing.

Table 4.2 – Probit Estimates for Heckman First-Stage Model: Likelihood of Engaging in Business Model Change

Probit estimates for Heckman first-stage model: Business model change (1/0)

	Model 1		Model 2		Model 3	
Variables	*Coeff.*	*S.e.*	*Coeff.*	*S.e.*	*Coeff.*	*S.e.*
Intercept	-6.76	10822.1	-1.71***	0.47	-1.61**	0.48
Firm age	0.01	0.04	0.03	0.04	0.03	0.04
Management team size (log)	0.39*	0.17	0.46**	0.17	0.45*	0.18
VC-backed (dummy)	0.06	0.13	0.01	0.13	-0.03	0.13
# Products on market	0	0.02	-0.01	0.02	-0.01	0.02
# Patents (yearly)	0.01	0.02	0.01	0.03	0.01	0.03
# Product awards (yearly)	0.14	0.12	0.08	0.13	0.07	0.13
# FDA Approvals (yearly)	0.84**	0.29	0.83**	0.29	0.82**	0.29
Alliance portfolio diversity	0.16	0.17	0.01	0.18	-0.08	0.19
Sector:						
- Administrative	-0.03	0.14	0	0.14	-0.01	0.14
- Medical	-0.31†	0.18	-0.33†	0.18	-0.36†	0.18
Time controls	Included		Included		Included	
Business model experimentation			-0.08	0.1	-0.09	0.1
# new alliances (yearly)			0.08***	0.02	0.14***	0.04
# new alliances squared					-0.01†	0
Log likelihood	-299.66		-284.93		-283.07	
LR chi-square Δ	/		29.47***		3.7†	

***p<0.001, ** p<0.01, * p<0.05, † p<0.1

BM change was measured in year t+1; independent variables measured in year t; n(companies)=193, n(observations)=794

Likelihood ratio (LR) test chi squares and significances were determined relative to the previous model

3.3.2 Heckman selection model

Based on the first-step model, we ran a Heckman selection model, which was thus a panel data probit regression of the likelihood of engaging in business model change behavior. The dependent variable measured whether firms engaged in business model change or not. The instrument variables in the Heckman model, i.e. the variables included in this model to measure the inverse Mills ratio and that are excluded from the second-step model, are the number of patents, product awards and FDA approvals a firm had received during year *t* and time dummies. The inverse Mills ratio that was calculated based on this model was then included in the second-step model to account for potential selection bias.

3.3.3 Second-stage Degree of Business Model Change Estimates

Table 4.3 presents the results of the Heckman's second-stage estimation including the inverse Mills ratio from the first-stage probit model in Table 4.2, and thus accounting for potential selection bias. The first model includes the control variables, but none of them have a significant effect on the dependent variable, which is the number of items of a firm's business model that have changed. The only variable with a significant effect on the dependent variable in this model is the inverse Mills ratio.

The second model is characterized by the addition of the explanatory variables. Business model experimentation has a significant negative effect on the dependent variable, thereby supporting H1b which stated that business model experimentation leads to more incremental business model change. The effect of number of new alliances on degree of business model change is not significant. The squared term of the number of new alliances in the third model is marginally significant, but positive. Since the number of new alliances is not significant and the squared term

Table 4.3 – Estimates for Heckman Second-stage Model

Negative binomial panel model: DV = Number of BM components that have changed

	Model 1		Model 2		Model 3		Model 4		Model 5	
Variables	*Coeff.*	*S.e.*	*Coeff.*	*S.e.*	*Coeff.*	*S.e.*	*Coeff.*	*S.e.*	*Coeff.*	*S.e.*
Intercept	0.58	0.75	1.56	1.15	2.11†	1.24	2.71*	1.28	2.81*	1.3
Firm age	0.06	0.09	0.96***	0.16	1.02***	0.17	1.15***	0.18	1.16***	0.18
Management team size (log)	-0.24	0.57	-0.46	0.74	-0.55	0.75	-0.8	0.73	-0.8***	0.73
VC-backed (dummy)	0.63	0.45	1.79	0.63	2**	0.65	1.8**	0.58	1.82**	0.58
# Products on market	-0.05	0.09	0.02	0.13	0.02	0.13	0.06	0.12	0.06	0.12
Alliance portfolio diversity	-0.42	0.43	-0.71	0.44	-0.65	0.45	-0.16	0.44	-0.16	0.44
Sector:										
- Administrative	0.26	0.65	0.14	1.45	0.14	1.48	2.03	2.28	2.03	2.31
- Medical	0.71	0.75	0.14	1.41	0.04	1.39	-0.56	1.51	-0.6	1.45
Inverse Mills Ratio	-1.92***	0.38	-2.02***	0.52	-2.44***	0.59	-2.38***	0.57	-2.46***	0.61
Business model experimentation			-2.64***	0.39	-2.67***	0.4	-3.32***	0.43	-3.31***	0.43
# new alliances			-0.03	0.06	-0.14	0.09	-0.08	0.06	-0.11	0.09
# new alliances squared					0.01†	0.01			0	0.01
Business model experimentation * # new alliances							0.14***	0.04	0.12*	0.05
Log likelihood	-177.12		-145.34		-144		-140.06		-140	
LR chi-square Δ	/		63.56***		2.69		10.56**		10.68**	

***p<0.001, ** p<0.01, * p<0.05, † p<0.1

DV measured in year t+1; independent variables measured in year t; n(companies)=77, n(observations)=390

All likelihood ratio (LR) test chi squares and significances were determined relative to Model 2, except for Model 2 which was compared to Model 1

has the opposite effect on the degree of business model change than the effect that was expected, we do not find support for the hypothesized inverted U-shaped relation between number of new alliances and degree of business model change (H2b).

The fourth model includes the interaction effect between business model experimentation and the number of new alliances. This effect is significant and positive in both this model and the full model (Model 5). As a result, we find support for H3 which stated that the number of new alliances would attenuate the negative effect of business model experimentation on the degree to which a business model changes. To illustrate this interaction effect, we plotted it as a graph in Figure 4.2

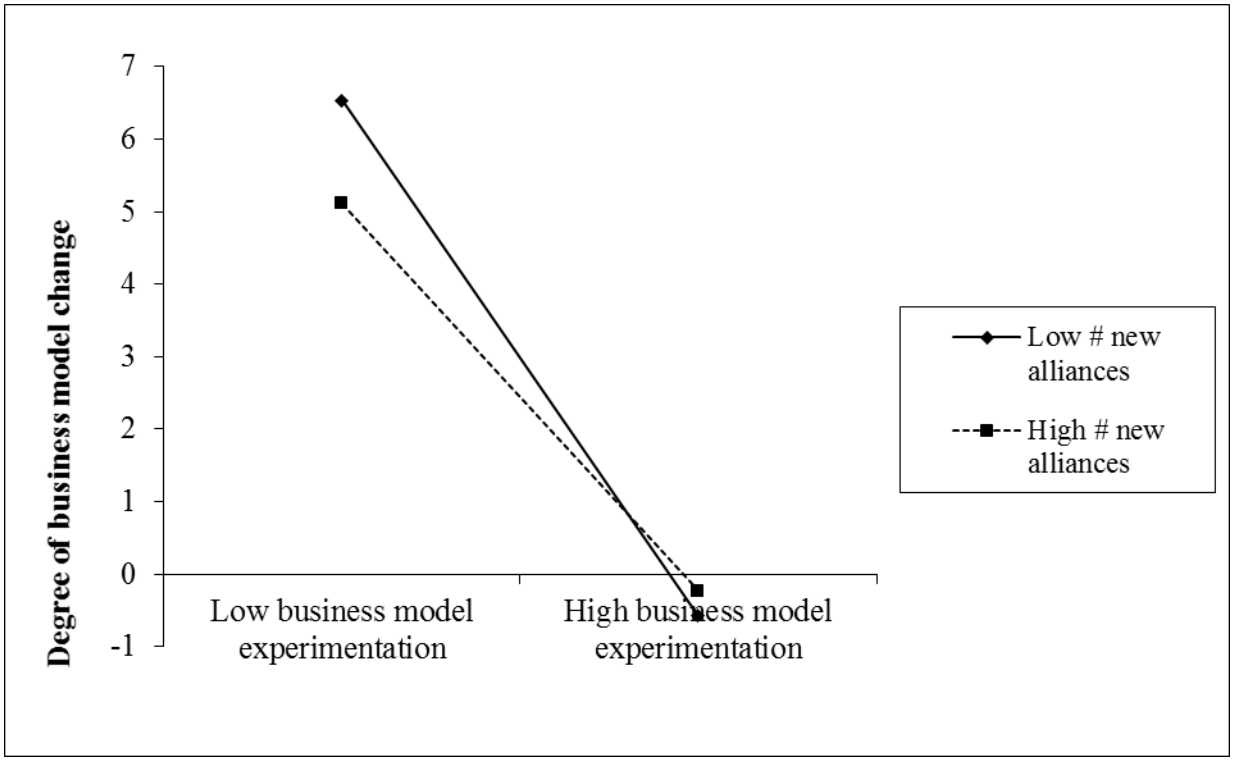


Figure 4.2 – Interaction effect between business model experimentation and number of new alliances

Figure 4.2 shows that firms with a lower score on business model experimentation will engage in more radical change than firms with a high score on business model experimentation, supporting

the main effect hypothesis (H1b). However, the degree of business model change also depends on the firm's number of alliances. Firms with a high number of new alliances will engage in more radical business model change than firms with a low number of alliances when the business model experimentation is high. When the business model experimentation is low, the situation will be the opposite: firms with a low number of alliances will engage in more radical business model change. The number of new alliances thus alleviates part of the negative relation between business model experimentation and the degree to which a firm's business model changes.

4.4 Discussion

This study was motivated by an important gap in the research on business models. Despite the importance of business models, which had been highlighted in a number of studies (e.g. Andries et al., 2013; Sarasvathy, 2001), only a handful of studies have investigated how and why business models change. Especially in emerging markets, in which no dominant design has been established (Santos & Eisenhardt, 2009), business model experimentation can be highly important as it still remains unclear how value can be created in the market (Teece, 2010). While Andries et al. (2013) provided some insights in the process of business model change by identifying the two concepts of focused commitment and simultaneous experimentation, they did not investigate which factors could predict whether or not firms would engage in business model change, nor did they investigate what influences the extent to which firms will change their business models. Moreover, previous studies on business model change adopted a case-study approach. To our knowledge, our study is the first to investigate business model change on a large scale. Furthermore, despite the intricate link between alliances and business models and the impact that alliances can have on business models, we are not aware of previous studies that have focused on how alliances can lead to business model change.

This study addressed these limitations by examining the joint and interactive influences of business model experimentation and establishing new alliances on a firm's likelihood of engaging in business model change as well as on the degree to which a firm's business model will change. We drew on effectuation and experiential learning theory to predict that firms engaging in business model experimentation behavior will be more likely to change their business models again and that the business model change in which these firms engage will be of a more incremental nature. Regarding the impact of new alliances on both the likelihood of engaging in business model change and the extent to which the firm's business model changes, we drew on research on alliances, interorganizational learning and business ecosystems. We argued that the relation between new alliances and the likelihood of engaging in business model change would follow an inverted U-shaped relation. Alliances can increase the likelihood of engaging in business model change by providing access to new resources and information, as well as by being a mechanism for learning and a mechanism by which the business ecosystem in which a firm is present can be shaped. On the other hand, we argued that more alliances make it more likely that the firm's business model will be more fixed and that the information brought in by new alliances will start to become more redundant and less novel, thereby decreasing the likelihood that they would lead to business model change. Similarly, we proposed an inverted U-shaped relation between number of new alliances and the degree to which a firm's business model change is radical.

The results are mostly consistent with the predictions of the theoretical framework. We found that while business model experimentation does not predict the likelihood of engaging in business model change, it is a significant predictor of undertaking more incremental business model change for firms that have changed their business model. For alliances, the hypothesized inverted U-shaped relation between number of new alliances and the likelihood of engaging in business model

change was supported, but the inverted U-shape relation with the degree of business model change was not found. We can thus conclude that the number of new alliances does not significantly predict more radical business model change. It does significantly moderate the relation between business model experimentation and the degree of business model change in the sense that it attenuates the negative impact of business model experimentation on the extent of radical business model change. In other words, firms that have experimented with their business models a lot will engage in more radical business model change if they have a higher number of new alliances. Firms with low values for business model experimentation, on the other hand, will engage in more radical business model change if they have fewer alliances.

4.5 Contributions

This study has several important implications. First, our study makes contributions to the business model literature by addressing the underresearched topic of business model change and its antecedents. Despite the importance of business model change (Andries et al., 2013; Perry et al., 2012), few studies have focused on this topic. By looking at experimentation and a firm's set of alliances, we have identified two drivers that play an important role in new ventures' business model change processes. Moreover, our study has looked at how these two drivers predict the degree to which a firm's business model change is radical. Not only do these findings make contributions to the business model literature, but also to the literature on organizational change, that has largely overlooked the change processes of new ventures in emerging industries (Ambos & Birkinshaw, 2010). Secondly, our study makes a contribution to the literature on alliances by showing that alliances can be seen as drivers of business model change and also have an indirect impact on the extent to which a firm changes its business model. Moreover, by focusing on alliance partners, our study also contributes to the growing research stream focusing on business

ecosystems (Adner & Kapoor, 2010; Kapoor & Lee, 2013), which states that a firm's success will depend on its partners and its integration with these partners in the ecosystem. By drawing on the theories on effectuation and learning, our study has also shown that these theories have applications in explaining the concept of business model change. In doing so, our study also responds to a recent call for more research on the link between business model change and effectuation (Perry et al., 2012). Finally, by focusing on new ventures in emerging markets, this study also contributes to the entrepreneurship literature, which has long focused on gaining deeper insights in new venture creation and evolution. Understanding business model change and the processes by which firms change their business models contributes to this goal.

4.6 Implications for practitioners

In addition to academic contributions, our study also has several managerial implications. First of all, our study provides insights into some of the drivers of business model change. Firms trying to change their business models, for example, may consider establishing new alliances that provide them with access to new resources and opportunities and that may make their move towards another business model more straightforward. Moreover, knowing that business model experimentation leads to more incremental change may be interesting for entrepreneurs, as it allows them to fine-tune their business model and engage in more incremental business model change. On the other hand, it may also decrease their ability to engage in more radical change later on. As such, entrepreneurs engaging in a trial-and-error process of business model experimentation should be aware that their business model might become increasingly fixed. To this end, alliances can be important. To break the pattern of business model experimentation leading to incremental change, firms may try to establish more alliances, as this may help them achieve more radical business model change. Having knowledge on how firms change their business models may also

be relevant to policy makers and incubators, as this knowledge may help them guide firms and aid them in changing their business models.

4.7 Limitations and future research avenues

The results and contributions of this study should be considered in light of their limitations. For example, we did not find significant support for the hypothesis that business model experimentation increases the likelihood of engaging in further business model change. While it may be the case that these two phenomena are in fact unrelated, a potential reason for lack of support for our hypothesis may also be that the period of interest in our study is too short. Some of the (especially younger) firms that have experimented with their business models in the past might engage in more business model change in the future, but this effect would not be captured in our study due to only studying change between 2005 and 2014. A second possible explanation for the lack of empirical support for this hypothesis is the fact that we were not able to distinguish between successful and unsuccessful business model changes. Firms that undertook successful business model changes in the past may try to strengthen or scale up their business models, instead of changing it again. When past changes were unsuccessful, however, new ventures may change their business models again in an attempt to improve their business models and attain a higher performance level. However, as we do not have data on whether past changes were successful or not, we cannot control for this in our analyses. In addition, we also did not find significant support for our hypothesis that more alliances would lead to more radical business model change. By breaking down the alliances with regards to their goal and type of partner, we could potentially find that some types of alliances, for example R&D and manufacturing alliances, lead to more radical business model change while others, such as alliances with suppliers/distributors or investors, would lead to only minor changes in the firm's business model.

Furthermore, even though we adopted a lagged effect in our study to ensure that reversed causality and simultaneity were not present in our study, our results cannot prove the causality between business model experimentation, alliances and likelihood and degree of business model change. In future studies, researchers could conduct interviews with some firms to gain deeper insights into whether or not a causal link between alliances, experimentation and business model change is present.

Additionally, due to our focus on new ventures in the emerging mobile health industry, our results may not be generalizable to other industries or to new ventures that are not active in emerging industries. While all of the measures used in this study are not specific to the mHealth industry, it is nevertheless possible that our findings are not generalizable to other industries. Future studies could thus investigate the antecedents of business model change in other industries and see whether or not our findings hold. Moreover, our sample is heavily biased towards the US mHealth industry, with only 4.3% of the firms being from other countries. Our findings may thus not be generalizable to other countries, which is a topic that could be studied in future studies.

Moreover, in this study, we only investigated the likelihood of engaging in business model change and analyzed to what extent firms change their business models. Future research should focus on which type of business model change, i.e. radical pivots or incremental tweaks, is best for the firms' performance and survival. Moreover, future research could investigate to what extent the two identified drivers of business model change lead to a different quality of change, e.g. a change in the venture's internal competences, target market or product offering. Similarly, future research could focus on whether business model change caused by business model experimentation or alliances lead to better outcomes for the firms. Finally, future research could also dig deeper into

an organization's initial business model and investigate whether some business model configurations are more susceptible to change than others.

4.8 Conclusion

In conclusion, this study's aim was to identify antecedents of business model change and analyze to what extent these antecedents influence the degree to which a firm's business model changes. By using a panel data set of new ventures in the mobile health industry, we were able to show that business model experimentation and alliances play an important role in a firm's business model change process. We also attempted to provide both conceptual and empirical bases for further investigation of this important topic and hope that our results will prompt new direction for research in the area.

4.9 References

Adner, R. & Kapoor, R. 2010. Value creation in innovation ecosystems: how the structure of technological interdependence affects firm performance in new technology generations. ***Strategic management journal***, 31(3): 306-333.

Ahuja, G. 2000. Collaboration networks, structural holes, and innovation: A longitudinal study. ***Administrative Science Quarterly***, 45(3): 425-455.

Ambos, T. C. & Birkinshaw, J. 2010. How do new ventures evolve? An inductive study of archetype changes in science-based ventures. ***Organization science***, 21(6): 1125-1140.

Amit, R. & Zott, C. 2001. Value creation in e-business. ***Strategic management journal***, 22(6-7): 493-520.

Andries, P., Debackere, K., & Van Looy, B. 2013. Simultaneous Experimentation as a Learning Strategy: Business Model Development Under Uncertainty. ***Strategic Entrepreneurship Journal***, 7(4): 288-310.

Bingham, C. B. & Davis, J. P. 2012. Learning sequences: their existence, effect, and evolution. ***Academy of Management Journal***, 55(3): 611-641.

Blank, S. 2013. Why the lean start-up changes everything. ***Harvard Business Review***, 91(5): 63-72.

Bruneel, J., Yli-Renko, H., & Clarysse, B. 2010. Learning from experience and learning from others: how congenital and interorganizational learning substitute for experiential learning in young firm internationalization. ***Strategic Entrepreneurship Journal***, 4(2): 164-182.

Burke, M. J., Finkelstein, L. M., & Dusig, M. S. 1999. On average deviation indices for estimating interrater agreement. ***Organizational Research Methods***, 2(1): 49-68.

Burke, M. J. & Dunlap, W. P. 2002. Estimating interrater agreement with the average deviation index: A user's guide. ***Organizational Research Methods***, 5(2): 159-172.

Burt, R. S. 1992. ***Structural Holes***. Cambridge, MA: Harvard University Press.

Calia, R. C., Guerrini, F. M., & Moura, G. L. 2007. Innovation networks: from technological development to business model reconfiguration. ***Technovation***, 27(8): 426-432.

Chesbrough, H. & Rosenbloom, R. S. 2002. The role of the business model in capturing value from innovation: evidence from Xerox Corporation's technology spin-off companies. ***Industrial and Corporate Change***, 11(3): 529-555.

Cohen, W. M. & Levinthal, D. A. 1990. Absorptive capacity: a new perspective on learning and innovation. ***Administrative science quarterly***: 128-152.

Crossan, M. & Sorrenti, M. 1997. Making sense of improvisation. ***Advances in strategic management***, 14: 155-180.

Crossan, M. M., Lane, H. W., & White, R. E. 1999. An organizational learning framework: from intuition to institution. ***Academy of management review***, 24(3): 522-537.

Cyert, R. M. & March, J. G. 1963. ***A Behavioral Theory of the Firm***. Englewood Cliffs, NJ: Prentice-Hall.

Dew, N., Read, S., Sarasvathy, S. D., & Wiltbank, R. 2009. Effectual versus predictive logics in entrepreneurial decision-making: Differences between experts and novices. ***Journal of Business Venturing***, 24(4): 287-309.

Fleming, L. 2001. Recombinant uncertainty in technological search. ***Management science***, 47(1): 117-132.

Gagliardi, P. 1986. The creation and change of organizational cultures: A conceptual framework. ***Organization studies***, 7(2): 117-134.

Gioia, D. A., Schultz, M., & Corley, K. G. 2000. Organizational identity, image, and adaptive instability. ***Academy of management Review***, 25(1): 63-81.
Greenwood, R. & Hinings, C. R. 1996. Understanding radical organizational change: Bringing together the old and the new institutionalism. ***Academy of Management Review***, 21(4): 1022-1054.
Gruber, M., MacMillan, I. C., & Thompson, J. D. 2008. Look before you leap: Market opportunity identification in emerging technology firms. ***Management Science***, 54(9): 1652-1665.
Gulati, R. 1995. Social structure and alliance formation patterns: A longitudinal analysis. ***Administrative Science Quarterly***, 40(4).
Hall, B. H. 2002. A note on the bias in the Herfindahl based on count data. In A. Jaffe & M. Trajtenberg (Eds.), ***Patents, citations and innovation***: 149-156. Cambridge, MA: MIT Press.
Hamel, G. 1991. Competition for competence and interpartner learning within international strategic alliances. ***Strategic management journal***, 12(S1): 83-103.
Haunschild, P. R. & Sullivan, B. N. 2002. Learning from complexity: Effects of prior accidents and incidents on airlines' learning. ***Administrative Science Quarterly***, 47(4): 609-643.
Hausman, J. 1978. Specification tests in econometrics. ***Econometrica***, 46: 1251-1272.
Heckman, J. J. 1979. Sample Selection Bias as a Specification Error. ***Econometrica***, 47(1): 153-161.
Kapoor, R. & Lee, J. M. 2013. Coordinating and competing in ecosystems: How organizational forms shape new technology investments. ***Strategic management journal***, 34(3): 274-296.
Levinthal, D. & March, J. G. 1981. A model of adaptive organizational search. ***Journal of Economic Behavior & Organization***, 2(4): 307-333.
Levinthal, D. A. 1997. Adaptation on rugged landscapes. ***Management science***, 43(7): 934-950.
Levitt, B. & March, J. G. 1988. ***Organizational learning***. Palo Alto, CA: Annual Reviews.
March, J. G. 1991. Exploration and exploitation in organizational learning. ***Organization Science***, 2: 71-78.
Maurer, I. & Ebers, M. 2006. Dynamics of social capital and their performance implications: Lessons from biotechnology start-ups. ***Administrative Science Quarterly***, 51(2): 262-292.
Osterwalder, A. & Pigneur, Y. 2010. ***Business Model Generation: A Handbook For Visionaries, Game Changers, And Challengers***: Wiley.
Perry, J. T., Chandler, G. N., & Markova, G. 2012. Entrepreneurial effectuation: a review and suggestions for future research. ***Entrepreneurship Theory and Practice***, 36(4): 837-861.
Phelps, C. C. 2010. A Longitudinal Study of the Influence of Alliance Network Structure and Composition on Firm Exploratory Innovation. ***Academy of Management Journal***, 53(4): 890-913.
Polidoro, F. 2013. The Competitive Implications of Certifications: The Effects of Scientific and Regulatory Certifications on Entries into New Technical Fields. ***Academy of Management Journal***, 56(2): 597-627.
Powell, W. W., Koput, K. W., & Smith-Doerr, L. 1996. Interorganizational collaboration and the locus of innovation: Networks of learning in biotechnology. ***Administrative Science Quarterly***, 41(1).
Read, S., Dew, N., Sarasvathy, S. D., Song, M., & Wiltbank, R. 2009. Marketing Under Uncertainty: The Logic of an Effectual Approach. ***Journal of Marketing***, 73(3): 1-18.
Ryan, T. P. 1997. Modern regression analysis: John Wiley & sons.

Santos, F. M. & Eisenhardt, K. M. 2009. Constructing markets and shaping boundaries: Entrepreneurial power in nascent fields. ***Academy of Management Journal***, 52(4): 643-671.
Sarasvathy, S. D. 2001. Causation and effectuation: Toward a theoretical shift from economic inevitability to entrepreneurial contingency. ***Academy of Management Review***, 26(2): 243-263.
Soh, P.-H. 2003. The role of networking alliances in information acquisition and its implications for new product performance. ***Journal of Business Venturing***, 18(6): 727-744.
Soh, P.-H., Mahmood, I. P., & Mitchell, W. 2004. Dynamic inducements in R&D investment: Market signals and network locations. ***Academy of Management Journal***, 47(6): 907-917.
Stinchcombe, A. L. 1965. Social structure and organizations. In J. G. March (Ed.), ***Handbook of organizations***: 142-193. Chicago: Rand McNally.
Teece, D. J. 2010. Business models, business strategy and innovation. ***Long range planning***, 43(2): 172-194.
Tiwana, A. 2008. Do bridging ties complement strong ties? An empirical examination of alliance ambidexterity. ***Strategic management journal***, 29(3): 251-272.
Van de Ven, A. H. & Polley, D. 1992. Learning while innovating. ***Organization science***: 92-116.
Zott, C. & Amit, R. 2008. The fit between product market strategy and business model: implications for firm performance. ***Strategic management journal***, 29(1): 1-26.

5. THE IMPACT OF BUSINESS MODEL CHANGE PROCESSES ON THE PERFORMANCE OF NEW VENTURES IN EMERGING INDUSTRIES

WITH HELENA YLI-RENKO AND BART CLARYSSE

5. THE IMPACT OF BUSINESS MODEL CHANGE PROCESSES ON THE PERFORMANCE OF NEW VENTURES IN EMERGING INDUSTRIES

A large number of studies in the organizational change literature have focused on how existing organizations evolve and what the implications of these change processes are on the performance and survival of these ventures. Examples of notable studies in the organizational change literature are studies by Tushman and Romanelli (1985) and Tushman and Anderson (1986) who proposed the punctuated equilibrium model, in which long periods of incremental change are interrupted by brief periods of discontinuous, radical change. In addition to studies that focus on the disruption of existing industries by new entrants in these industries and the performance implications thereof, a number of studies also investigated the notion of continuous improvement, in which firms continuously undertake incremental change processes (Brown & Eisenhardt, 1997; Rindova & Kotha, 2001). One thing that most of these studies have in common is their focus on established ventures (e.g. Dobrev, Kim, & Carroll, 2003). Moreover, these established ventures were also most often studied in the context of established industries that are faced with a disruption, caused by new entrants (Hill & Rothaermel, 2003). As a result, the vast majority of organizational change theory is tailored to established ventures (Ambos & Birkinshaw, 2010) and to the notion of fit between an organization and its changing environment. This goal of fit encourages firms to undertake change when the environment changed, or discourages firms to undertake change, when the fit between the organization and environment is still there.

Few studies, however, have specifically focused on how new ventures, active in emerging industries evolve and change. Due to liabilities of newness and smallness (Aldrich & Auster, 1986; Stinchcombe, 1965), new ventures typically have limited financial, technological and human resources and little power over other actors (Ambos & Birkinshaw, 2010). As a result, new ventures' actions will typically primarily be driven by short-term goals and performance, such as new product introductions and survival, rather than profitability (Ambos & Birkinshaw, 2010; Graebner, 2004). As a result, the organizational change processes of new ventures will be different from those from established ventures. Moreover, previous studies have mainly focused on incumbents' actions and organizational change processes in response to disruptive actions by new entrants, rather than focusing on these new ventures themselves. As a result, little is known about the organizational change processes of new ventures in emerging industries. An emerging industry is defined as "a business environment in an early stage of formation" (Santos & Eisenhardt, 2009, p. 644) and is characterized by an undefined industry structure, unclear or missing product definitions and a lack of a dominant logic to guide actions. New ventures active in emerging industries thus do not only face their own lack of legitimacy and resources but, in order to ensure their own success, also need to work on building and legitimating the emerging industry (DiMaggio, 1991; Maguire, Hardy, & Lawrence, 2004; Rao, Morrill, & Zald, 2000).

As all organizations started out as new ventures and most established industries were emerging at some point, gaining deeper insights into how new ventures in emerging industries evolve and how their change processes impact their performance is important. Given the importance of this topic, combined with the lack of previous studies addressing the specific contingency of new ventures in emerging industries, we attempt to address this gap in this study, by providing an answer to the research question: "How do the organizational change processes of new ventures in emerging

industries have an impact on their performance?" Although the existing organizational change literature did not aim to explain new ventures' actions in emerging industries, we nevertheless will draw on this literature to develop our theory and test our hypotheses. We also draw on the entrepreneurship literature, in which some recent studies have begun to focus on explaining change mechanisms of new ventures (e.g. Ambos & Birkinshaw, 2010; Furr, Cavarretta, & Garg, 2012). Moreover, due to our choice to conceptualize new ventures' organizational change processes as business model changes, we also draw on the business model literature.

To address our research question, we draw on a sample of 173 new ventures, active in the emerging mobile health industry. The mobile health industry, which is at the intersection between telecommunications, IT and the health industry, is an emerging market. We have longitudinal data ranging from 2005 till 2014 for our sampled firms and investigate to what extent business model changes, the degree of business model change and the time between business model changes has an impact on the new ventures' performance. As new ventures are typically mainly driven by short-term goals, we conceptualize performance in three different ways that reflects these short-term goals (Ambos & Birkinshaw, 2010). These three conceptualizations are the number of new product introductions into the market, the likelihood of surviving as an independent venture, meaning not getting acquired or not failing, and the likelihood of not being acquired[8].

Our study has multiple contributions. First of all, it makes contributions to the organizational change literature by testing established findings from the organizational change literature in the setting of new ventures in emerging markets. Secondly, we also contribute to the business model literature. By focusing on the concept of business model and business model change, we were able

[8] Not being acquired is seen as high performance. However, in the survival analyses, getting acquired is the failure event. As such, in the hypotheses, high performance will be seen as lower chances of getting acquired.

to show that business model changes can significantly influence the performance of new ventures active in emerging markets. Thirdly, our study contributes to the entrepreneurship literature and to previous calls for more research on the impact of organizational change on performance among new ventures (Furr et al., 2012). Finally, by focusing on the performance implications of new ventures' change processes in emerging industries, we contribute to studies on new venture and industry evolution.

5.1 Theory and Hypotheses Development

Research on organizational change typically models this change as a punctuated equilibrium process, in which long periods of incremental movement are interrupted by brief periods of discontinuous, radical change (Tushman & Anderson, 1986), whereby radical change is defined as "frame bending" change that involves "busting loose from an existing 'orientation'" (Greenwood & Hinings, 1996, p.1024) and incremental change occurs when firms fine-tune their existing orientation or configuration (Greenwood & Hinings, 1996). In studies focusing on innovation, the focus has mostly been on radical and disruptive change, thereby largely overlooking processes of more incremental and continuous change (Brown & Eisenhardt, 1997). In response to this gap, we do not only investigate whether business model change increases a firm's performance, but also how the degree of business model change, i.e. more radical versus more incremental change, affects the firm's new venture performance. Moreover, we investigate the role of the time between business model changes on new venture performance, as this variable allows us to classify firms' business model change processes as continuous or discontinuous change efforts. In the next hypothesis, we then investigate how degree of business model change and time since last business model change interact and impact new venture performance. The advantage of this approach is that this study does not limit itself to a specific type of change process

as was done in most previous studies, thereby typically focusing on continuous, incremental change (e.g. Brown & Eisenhardt, 1997; Rindova & Kotha, 2001) or on disruptive radical change (e.g. Tushman & Anderson, 1986; Tushman & Romanelli, 1995); rather, this study allows for all combinations of frequency and degree of business model change.

When investigating the impact of changes in a firm's business model, it is important to have a clear definition of what exactly a business model is. We adopt the definition of Chesbrough and Rosenbloom (2002, p. 532) and define a business model as "a coherent framework that takes technological characteristics and potentials as inputs and converts them through customers and markets into economic outputs". In other words, changes in a firm's business model can thus refer to changes in the input that the firm uses, i.e. the technological characteristics and internal capability factors of the firm, as well as to the economic outputs that the firm delivers, which are characterized by the firm's product offering and by economic and investor factors, as well as the value creation process in between, in which competitive strategy and market factors play a role.

4.1.1 Impact of business model change on performance

New ventures that are active in an emerging industry are usually confronted with high levels of complexity, both on the environment level as on the product level. Typical for an emerging industry is a lack of a dominant logic that can guide firm actions (Kaplan & Tripsas, 2008), unclear or missing product definitions (Hargadon & Douglas, 2001) and an undefined industry structure (Eisenhardt, 1989; Rindova & Fombrun, 1999). The uncertainty and lack of information can make it hard for new ventures, starting up in these emerging industries, to make well-informed decisions, write detailed business plans and ultimately start up their venture.

Some scholars have argued that, in response to these high levels of uncertainty, new ventures should start up following an effectual approach, in which they start up their venture with a general goal in mind, but in which they do not have a specific business plan or model that they should stringently follow (Sarasvathy, 2001). Effectual entrepreneurs should remain flexible, take advantage of environmental contingencies as they arise and learn as they go (Perry, Chandler, & Markova, 2012), thereby fine-tuning their goals over time. Factors such as strategic alliances, customer feedback, access to resources and changes in the environment can enable entrepreneurs to make changes to their ventures' goals as well as to how they will create value, thereby also influencing their business models. In other words, business model experimentation, or trying out different business models, is put forward as a mechanism to start up a venture in an uncertain environment. Blank (2013) even goes one step further by suggesting that a start-up's primary goal should be business model experimentation.

Given that there are only a few studies that focus on business model change, or even on organizational change, among new ventures, we draw upon arguments used in the organizational change literature for established ventures in building our first hypothesis in which we investigate whether business model change is positive or negative for new ventures' performance, measured as new product development and survival and acquisition status.

A point of consensus in the organizational change literature is usually that there should be a match, or what is called "fit", between the environment and the organization, and that stability and standardization of a form positively affect an organization's access to resources (Hannan & Freeman, 1984; Rindova & Kotha, 2001). Stability leads to consistent actions and outcomes, which are valued by resource holders (Hannan & Freeman, 1989), and standardization enhances the legitimacy of a firm's form (Hannan & Carroll, 1992). In other words, change is seen as an

unnecessary evil, as long as there remains fit between the organization and its environment. As soon as the environmental or resource conditions change, organizations need to change to increase their chances of survival (Hannan & Freeman, 1984). Some advantages of engaging in change are that it can allow the organization to respond to changes in the environment and regain fit between the organization and environment (Rindova & Kotha, 2001), and also that it allows firms to respond to new opportunities and can help build competitive advantages (Rindova & Kotha, 2001). Moreover, engaging in change behavior can be an antecedent of dynamic capabilities (Rindova & Kotha, 2001), which can enable the firm to create, deploy and protect intangible assets that contribute to the firm's long-term performance (Teece, 2007). Some disadvantages of change are that employees or other members of the organization can oppose the change and need to be encouraged to adopt new practices (Battilana & Casciaro, 2012; Van de Ven, 1986), that organizational change typically consumes a lot of resources and time (Bohnsack, Pinkse, & Kolk, 2014), and that organizational change can be inherently risky, and can thereby decrease the firm's performance or even likelihood of survival (Dobrev et al., 2003; Singh, House, & Tucker, 1986).

As we study new ventures that are active in an emerging industry, and thus where uncertainty will likely be high (Santos & Eisenhardt, 2009), we argue that the advantages of change will outweigh the disadvantages. First of all, external fit between an organization and a dynamic environment will be harder to achieve, thereby also making it less likely that fit will go lost because of the organization's business model change. Moreover, given the uncertainty and complexity of the emerging industry, it would not be very likely that firms get their business models completely right, the first time around, without needing any change (Teece, 2010). Moreover, new ventures' employees will be more used to working in a flexible environment, making it less likely that they oppose change. Finally, as new organizations are typically less constrained than older firms

(Ambos & Birkinshaw, 2010; Bohnsack et al., 2014), which can also in part be explained because they have fewer resources at their disposal, they are less likely to suffer negative consequences of engaging in organizational change (Dobrev et al., 2003). Therefore, I hypothesize that for new ventures in emerging industries, the advantages of change will outweigh the disadvantages, and that business model change will thus have a positive impact on their performance, measured as new product development and likelihood of ceasing to exist as an independent venture or likelihood of not getting acquired.

> ***H1: Firms that have changed their business models at least once will have a higher number of products on the market and will have higher survival chances as an independent venture and lower chances of being acquired than firms that have never changed their business models.***

In this first hypothesis, we tested how firms that had never changed their business models differ from firms that had changed their business models at least once, with respect to performance. Now, we will dig a bit deeper in specific business model processes and characteristics of firms that have changed their business models at least once.

4.1.2 Impact of degree of business model change on performance

Radical change is often heralded as a necessary mechanism for innovation, allowing firms to break away from previous orientations or architectures (Furr et al., 2012; Greenwood & Hinings, 1996). In order to ensure their long-term survival, it is argued that many organizations will be dependent on their ability to, at least at some point, be able to engage in radical change (Amis, Slack, & Hinings, 2004). However, this necessity to be able to engage in radical change is more applicable to established firms. Typically, although not exclusively, new entrants introduce competence-

destroying changes in an existing industry, thereby forcing the incumbents to adapt to this change in order to ensure their survival (Hill & Rothaermel, 2003). Radical change is thus often the mechanism used by established firms to respond to disruptions into the industry that were introduced by new entrants.

Incremental change is largely seen as the continuous process of small changes that take place in between the disruptive, or radical changes (Amis et al., 2004). It is often seen as a form of trial-and-error learning, in which firms undertake a course of action whereby the consequences of that completed action will lead to changes in the firm's knowledge or action base (Bingham & Davis, 2012). When actions are deemed unsuccessful, the entrepreneurs will intervene and make adequate changes (Bingham & Davis, 2012; Van de Ven & Polley, 1992).

Incremental change does not necessarily have to be continuous, and radical change disruptive, however. There is little guidance in the literature on how the extent to which a firm changes its business model, i.e. more radical versus more incremental changes, will affect its performance when decoupling it from the frequency of change, which is exactly why we address this in our study. Moreover, to our knowledge, no studies have exclusively focused on new ventures in an emerging industry when analyzing organizational change. Due to our focus on emerging industries and new ventures, most of the effects of new entrants that thereby disrupt the industry and cause incumbents to undertake organizational change, as was the focus in most previous studies, will level out and thereby not drive our results.

When relying on the organizational change literature, we are nevertheless able to find some studies that guide us in our hypothesis building of the impact of the degree of change on performance. Hannan and Freeman (1989), for example, have shown that complexity increases the risk of mortality due to reorganization, thereby suggesting that more radical business model changes

would have a negative effect on the firm's survival. Moreover, while organizational identities can change over time, it is suggested that organizations retain continuity in their essential features (Gagliardi, 1986; Gioia, Schultz, & Corley, 2000). Changes in a firm's business model that are too radical could create a mismatch between the firm's competences, business model and organizational identity. Finally, in his study on exploration and exploitation, March (1991) has argued that there should be a balance between exploration, which in this study could be seen as more radical business model change, and exploitation, which translates into refining, implementing and executing business models and thus more incremental business model change. Firms engaging in too much exploration risk having too many undeveloped new ideas and too little distinctive competences.

Although some of these challenges related to radical change may be less applicable to new ventures, for example because they typically do not have a clear organizational identity (Ambos & Birkinshaw, 2010) and are thus less constrained by it, there are other additional challenges that new ventures have when they engage in more radical organizational change. New ventures, for example, are typically characterized by a lack of resources (Ambos & Birkinshaw, 2010), which are needed to be able to engage in radical change, and which can also be used as a buffer in case the changes that the firm undertook do not have the desired outcomes. Moreover, new ventures in emerging industries also need to work on establishing the industry. Making radical changes in their business models can potentially have the effect of creating confusion and lack of clarity towards the market with respect of what the emerging industry is about, and which customer needs the firms in this industry are trying to address. As a result, this could potentially harm the success of the emerging industry, and thus the performance of the new ventures in it. For these reasons, we

argue that more radical business model change will have a negative impact on the firm's performance[9].

H2: The degree of business model change will have a negative impact on new ventures' performance, such that more radical business model changes will lead to fewer new product introductions, lower survival rates as independent ventures and higher likelihoods of being acquired.

4.1.3 Impact of time since last business model change on performance

Previous research has distinguished between continuous and disruptive change, also labelled evolutionary or interdependent and revolutionary change (Greenwood & Hinings, 1996), whereby evolutionary change occurs slowly and gradually, and revolutionary change happens swiftly. As mentioned before, most studies in organizational change have linked the impact of the degree of change, i.e. radical versus incremental, to the frequency of change, i.e. continuous versus disruptive. As a result, most studies focus on either disruptive radical change, as is the case in the punctuated equilibrium model of Tushman and Romanelli (1985), or on continuous incremental change, such as in studies executed by Brown and Eisenhardt (1997) and Rindova and Kotha (2001).

Only a limited number of studies address a different combination between frequency and degree of change. Plowman et al. (2007), for example, study how small, evolutionary changes can evolve

[9] More radical business model change would mean that firms drastically change some or all of the business model items. An example could be a change from a B2C (business-to-consumer) business model to a B2B (business-to-business) business model, which should also have implications for the distribution channels the firm should use, the market needs the firm's offering should target etc. An example of a more incremental business model change could be expanding the geographic region in which the firm is active. While internationalization typically creates some additional challenges for firms, such as not being familiar with the cultures of the new countries in which they are active, the product offering, market needs addressed and positioning in the market could remain the same.

into radical change, labelling this phenomenon as "accidental radical change" and Amis et al. (2004) show that, contrary to popular belief, radical change does not have to be a rapid, or disruptive, event. To our knowledge, however, no studies have focused on what the impact is of the time between organizational or business model changes on the firm's performance. To gain more insights into the potential advantages and disadvantages of a shorter or longer time between business model changes, we again look for indications in the organizational change literature.

The advantages of a short time between change events are mainly discussed in the continuous improvement literature. Rindova and Kotha (2001), for example, argue that continuous change can allow firms to regenerate competitive advantage under conditions of rapid change, by comprehensive and continuous redefinition of the products and services the firm provides, and changes in the resources and capabilities that the firm deploys. Moreover, continuous change can be seen as one of the antecedents to develop dynamic capabilities, which can facilitate further continuous change. Also a number of other studies by Eisenhardt (1989) and Brown and Eisenhardt (1997), argue that the ability to engage in rapid and relentless continuous change is a crucial capability for survival in high-velocity industries with short product cycles and rapidly shifting competitive landscapes, as is the case in emerging markets. There are also a number of entrepreneurship scholars who have argued that, especially when confronted with uncertainty, firms should experiment with a range of business models, and should adapt these business models based on the information and new opportunities that arise along the way (Andries, Debackere, & Van Looy, 2013; Perry et al., 2012; Sarasvathy, 2001), thereby suggesting more frequent business model changes. In a third stream of studies, authors have shown how trial-and-error or experiential learning can provide benefits to firms, by engaging in a continuous cycle of making changes and learning from these changes (Bingham & Davis, 2012). Finally, a number of studies in the

organizational change literature have shown how inertia, or lack of change, can increase the likelihood that a firm fails and can decrease the chances of success when an inert firm decides to engage in a change process after all (Dobrev et al., 2003), thereby supporting the notion that a shorter time between changes is good for the firm's performance.

There are also studies, however, that focus on the disadvantages of continuous change, where it is argued that frequent change can be a sign that the previous organizational changes were ineffective or not well-executed. Beck, Bruderl, and Woywode (2008) argue that change is aimed at improving organizational structures and processes, and that there should consequently be less need to engage in organizational change again if the organization has already changed in the past before. Each additional change process would refine the previously undertaken change and should make it less likely that the organization would engage in another round of change. If firms keep on changing, this could be a sign that their previous change was not well-executed or was not effective, given the problem or situation they were facing that called for the change in the first place. Following this logic, a shorter time between changes or a more continuous change process could reflect the ineffectiveness or negative outcomes of past organizational changes, thereby likely decreasing the firm's performance. Moreover, shorter times in between changes, i.e. more frequent changes, could make it more likely that the organization loses continuity in its organizational identity or business model, thereby potentially hurting the organization's performance, as it is suggested that organizations retain continuity in their essential features (Gagliardi, 1986; Gioia et al., 2000).

Though there are some disadvantages related to engaging in continuous change, which in our case would mean a short time between business model changes, we argue that the advantages of this type of change will outweigh the disadvantages. As the ventures in this study are new ventures active in an emerging industry, there will be a high level of uncertainty, making change more

necessary for these firms than for more established firms in more stable environments. As the industry unfolds, responding to the external information, opportunities and resources that arise, is a way in which firms can mitigate some of the uncertainty (Perry et al., 2012; Sarasvathy, 2001). As a result, we argue that engaging in more frequent change will be beneficial to the new venture. Moreover, as new ventures will rarely get their business models right the first time around (Bohnsack et al., 2014), changing it in response to customer needs and other opportunities that arise will be beneficial, rather than pose a lack of continuity in the rather short history that the firm has. Moreover, as new ventures are young and for the most part unencumbered by tradition, this should make the process of change relatively more straightforward for them than it would be in an established firm (Ambos & Birkinshaw, 2010), thereby increasing the likelihood that shorter times between changes will be beneficial for new ventures than it would be for established ventures. In short, we argue that shorter times between subsequent business model changes will have a positive impact on the firm's performance, or:

> ***H3: The time since last business model change will have a negative effect on a new venture's performance, such that firms who have a longer time in between their business model changes will have a lower number of new products developed, will have lower survival rates as independent ventures and will have a higher likelihood of being acquired.***

4.1.4 Interaction between degree of business model change and time since last business model change on performance

In this section, we will discuss how degree of business model change and time between business model changes can interact with each other and how this interaction can influence new ventures' performance.

In a previous section, it was argued that a higher degree of business model change has a significant negative impact on new venture performance. The arguments that were used to support this reasoning were the fact that more complex changes, such as radical change, increase the chance of failure (Hannan & Freeman, 1989), especially for new ventures that typically lack resources. Moreover, radical change can cause a loss of identity or discontinuity in the firm's activities and can destroy the skills set and competitive advantage that a firm established (Gagliardi, 1986; Gioia et al., 2000).

It is likely to believe, however, that the effects of the degree of change are dependent on the time since the firm's last business model change. For example, the loss of identity or discontinuity in a firm's activities will likely be more paramount in cases in which the firm engages in frequent, radical business model changes, but are less likely to be problem if the radical change is sporadic. Furthermore, it has been argued that many organizations at some point in time will need to engage in radical change to ensure their survival (Amis et al., 2004). More radical change does thus not always bring negative performance implications with it. Similarly, March (1991) has argued that there should be a balance between exploration, which in this study could be seen as more radical business model change, and exploitation, which translates into refining, implementing and executing business models and thus more incremental business model change. While firms engaging in too much exploration risk having too many underdeveloped new ideas and too little distinctive competences, firms that engage in too much exploitation often jeopardize their long-term survival for their short-term performance. As such, we argue that the time since last business model change will mitigate the impact of degree of business model change on performance.

When looking at the case of incremental business model changes, there are also indications from the previous literature that the time since last business model change would interact with the degree

of business model change. For example, some of the main advantages of incremental change that are given in the literature are that it allows firms to engage in small, stepwise changes that allow the firm to learn from these changes and their consequences (Bingham & Davis, 2012). When incremental change is combined with continuous change, it allows firms to regenerate competitive advantage under conditions of rapid change and in high-velocity industries (Rindova & Kotha, 2001). When firms only sporadically make incremental changes to their business models, these firms can be seen as inert, which has two potential negative performance implications for these firms. The first one is that inert firms are less likely to obtain or maintain fit with changing environments, and secondly, when inert firms do engage in change, they are more likely to fail than others (Dobrev et al., 2003).

As a result, we argue that the time since last business model change will mitigate the negative impact of degree of business model change on performance, such that firms engaging in continuous, incremental change will outperform firms engaging in discontinuous, incremental change and firms engaging in discontinuous, radical change will outperform firms engaging in continuous, radical change.

> ***H4: Time since last business model change will mitigate the negative impact of degree of business model change on performance, such that firms that engage in more radical business model change will have a higher performance, i.e. more products on the market, higher survival rates as independent ventures and a lower likelihood of being acquired, if the time since last business model was longer, and firms that engage in more incremental business model change a lower performance if the time since last business model was longer.***

Figure 5.1 below summarizes the hypotheses of this study.

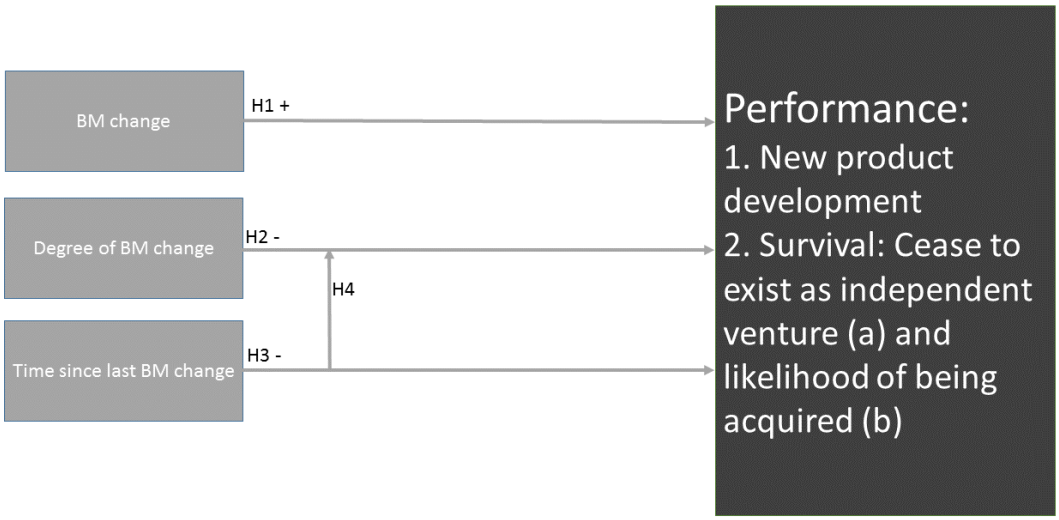


Figure 5.1 – Overview of hypotheses in this study

5.2 Methodology

4.2.1 Sample and data

We use a sample of 173 new ventures, active in the emerging mobile health industry, to test our hypotheses. We refer to Chapter 3 for more detailed information on how the sample was established and the data collection process was conducted.

4.2.2 Measurement: Dependent variables

New ventures often to do not have sales or revenues yet. Moreover, as the different mHealth segments can be seen as quite distinct in their way of operating, launching products and payment models, revenues would not necessarily be an adequate measure of performance in this case. As a result, we chose to use three distinct measures of new venture performance that reflect the more

short-term goals that new ventures typically have (Ambos & Birkinshaw, 2010). These three variables are the number of new product introductions and the survival of the firm, measured as the likelihood of ceasing to exist as an independent venture and as the likelihood of being acquired.

New product introductions in year t. The introduction of new products and services is a critical determinant of organizational performance. By introducing new products and services, organizations can establish new markets and technologies and adapt and change to meet new market demands (Smith, Collins, & Clark, 2005). New product development is therefore often used as a performance indicator, as it represents the potential commercial value of a firm's R&D activities, and is often used in studies on technology-based ventures, in which competitive technologies and customer needs can develop and change rapidly (Yli-Renko & Janakiraman, 2008). New product development and the introduction of these new products in the market can therefore be seen as improving the firm's market share, market value and ultimately, its survival (Katila & Ahuja, 2002).

We measured new product introductions on the basis of the number of products a firm had on the market during a given year. We determined this number of products on the basis of press releases and company websites. When missing values were present, we extrapolated the number of products on the market on the basis of the values that were available by assuming a firm-specific fixed growth rate for number of products on the market. Then, we calculated the number of new product introductions by subtracting the value of the number of products on the market during year *t-1* from the number of products on the market in year *t*. Negative values were excluded and set equal to 0. In other words, product recalls were not included in this measurement. We log-transformed this variable due to its skewness.

In the first analysis (corresponding to hypothesis 1), the total number of products on the market at the end of 2014 is used as the dependent variable. In models in which number of new product introductions or number of products on the market is not the dependent variable, i.e. in the models where survival is the dependent variable, the number of products on the market was used as a control variable.

Survival. New ventures' primary goal is usually not profitability, but survival (Ambos & Birkinshaw, 2010; Graebner, 2004). As a result, we include a firm's survival as a performance indicator in this study. We measure survival in two ways. In our first measurement, we see failure, or the lack of survival, as either getting acquired or failing. Like this, only firms that remain active as an independent venture are seen as surviving firms. In our second measurement of survival, we use acquisition as the event of failure, and all firms that are not acquired are thus seen as surviving. Ideally, we would also be able to use actual failure, or firms ceasing to exist, as a failure event. However, there were only five firms in the entire sample that failed during the time of analysis, and only three of them had changed their business models. As a result, we did not have enough observations of failure to be able to run a reliable model with failure as the outcome variable.

The survival status of the sampled firms was determined on the basis of press releases, industry reports and company websites. Three dummy variables were created, that indicate the firm's status at the end of a given year. These three statuses are *active, acquired* and *failed* [10].

4.2.3 Measurement: Independent variables

[10] For the sake of completeness, the failure dummy was included in the descriptive statistics and correlation tables. It was not used in any analysis, however.

Business model change dummy. This variable measures whether the sampled firms had changed their business models at least once during the period of their founding till their last year of existence as an independent venture or till 2013, whichever came first. Business model change was measured using the categorization scheme by Andries et al. (2013) (see also appendix A). For each year of the firm's existence, two independent raters coded each firm's business model. As soon as one of the 26 items that jointly make up a business model were changed, we coded this as a business model change for the firm. The average deviation (AD) index for this variable was 0.23, which is lower than the suggested threshold of 0.33 for dichotomous variables and thus shows a high degree of agreement between both raters (Burke & Dunlap, 2002)[11].

Degree of business model change. Degree of business model change was measured on the basis of the same categorization scheme by Andries et al. (2013). We counted the number of items that a firm had changed during a given year. The more items a firm changed (maximum possible value = 26), the more radical a firm's business model change was considered to be. Due to the skewed nature of this variable, we log-transformed it. The AD index was 0.27, which was below the suggested threshold, thereby again supporting the high agreement between both raters for this variable (Burke & Dunlap, 2002).

Time since last business model change. This variable measures the time in years since a firm's most recent business model change. In order to have a meaningful value for this variable for every year, and thus also for the period in between the firm's founding and the firm's first business model change, we coded this variable in the following way. For the period between a firm's founding and a firm's first business model change, we gave this variable the same value as firm age. In other

[11] For more information on the average deviation (AD) index, its calculation, and the suggested thresholds, see Appendix B.

words, we made the assumption that a firm's initial business model, the one with which it starts up, is the first business model change the firm makes. Then, we counted the time from start-up till the firm's first business model change in years. For the period after a business model change, we started counting again after the business model change. As an example, consider a firm that was founded in 2006 and undertook two business model changes, one in 2009 and one in 2010. For 2009, the value for time since last business model change would be three, and for 2010, the value for time since last business model change would be 0, indicating that the firm changed its business model in the previous year[12]. The AD index of 0.58 for this variable again proved that the inter-rater agreement for this variable was acceptable (Burke & Dunlap, 2002).

4.2.4 Measurement: Control variables

Sector. Sector is a set of three dummy variables that indicate the mobile health industry sector in which firms are active. For a more detailed discussion of the three mHealth segments and examples of companies in each segment, along with their activities, see Chapter 3, section 3.4. The three categories are *administrative, fitness and wellness* and *medical* and were coded on the basis of each company's activities. *Fitness and wellness* was used as the reference category.

Firm age. Older firms are generally less flexible than younger ones (Soh, 2003; Stinchcombe, 1965). As a result, the change processes of ventures, along with their success, can be influenced by their age and the rigidities that the firm has built over time. Moreover, older organizations typically have a greater margin of error that allows them to buffer negative repercussions of change (Dobrev et al., 2003). To account for this potential impact of firm age on the performance

[12] Note that we only consider the firm's initial business model as a business model change for this variable. When selecting the firms that changed their business models for the second-step Heckman analyses, or when analyzing the degree of business model change, the initial business models were not taken into account or used as a change event.

implications of business model change processes, we included this variable as a control variable in our models. Firm age was measured by subtracting the founding year of the firm from the year under study.

External funding raised. Undertaking organizational change can be risky, especially when ventures lack financial resources (Ambos & Birkinshaw, 2010). We therefore include the cumulative amount of external funding as a control variable to account for the potential different impacts on performance that business model changes may have due to the firm having higher or lower amounts of funding at its disposal. We measured this variable as the cumulative amount of external funding, i.e. VC and angel funding, as well as grants received, prize money won and bank debts received, raised in thousands of USD (or USD-equivalent). The data was collected on the basis of press releases and industry reports. Due to its skewness, we log-transformed this variable.

Founding team experience. Founding team experience was measured by three separate variables that measure the percentage of founders that had technical experience, market experience or start-up experience prior to founding the venture. Since we study the mobile health industry, we translated technical experience into IT experience, and market experience into experience in the health industry. All information on the founding team's prior experience was obtained from the company's websites, LinkedIn and Zoominfo (e.g. Furr et al, 2012). We counted the number of founders that had experience in each of the three domains (IT, health, previously started up a venture) and divided them by the total number of founders the venture had to calculate each experience variable as the percentage of founders with this type of experience.

Management team size. This variable captures the number of entries into or exits from a venture's management team and the potential impact this may have on the success of a firm's business model change. Moreover, it can also be considered as an indicator of firm size. This variable measures

the number of management team members a firm has during year *t*. The data was collected on the basis of company websites and press releases. We calculated missing values by assuming a fixed growth rate, and extrapolated the values for the management team size on the basis of the existing values.

VC-backed. Andries et al. (2013) argue that that it can be difficult for firms to convince their venture capital (VC) investors that they need to change their business models. VCs could question whether the initial business model was wrong or whether potential problems that may have arisen were not just due to poor execution of the firm. They also provide empirical evidence, however, that in other cases, VCs may not mind business model change as it reflects a firm's adaptation to a changing and uncertain environment. The VC's opinion and support on the necessity of the business model change can thus potentially have an impact on the successful implementation of this change and on the impact of this change on the firm's subsequent performance. For these reasons, we include this variable as a control variable. It was measured as a dummy variable taking on the value of 1 if a firm was VC-backed during a given year *t* and 0 otherwise.

Number of FDA approvals. This variable measures the number of FDA (Food and Drug Administration) approvals a firm received for its products/services. Companies active in the non-regulated segment (i.e. fitness and wellness) will generally not have FDA approvals. However, for those companies falling into the other two categories, FDA approval may be a requirement to be able to market their product. Getting FDA approval could thus have an important impact on the number of products a firm has on the market or on its survival. Moreover, FDA approval can be seen as an important source of legitimacy (Polidoro, 2013), potentially leading to an increased performance. FDA approval is measured as the number of approvals the firm has received during year *t* and was collected using the US FDA website.

Product awards. The number of product awards a firm receives can be seen as a certification by the market. Awards are social cues that can assist decision making under uncertainty (Polidoro, 2013; Soh, Mahmood, & Mitchell, 2004). Product awards could thus encourage customers to adopt products by the firm, thereby potentially having a positive impact on the firm's performance. Information on product awards was obtained from the firm's press releases.

Patents. Patents can be seen as a signal of the technological quality of a firm (Haeussler, Harhoff, & Mueller, 2014; Hoenen, Kolympiris, Schoenmakers, & Kalaitzandonakes, 2014; Useche, 2014). As a result, patents can lead to increased legitimacy for new ventures and ultimately to an enhanced performance. Patent data was collected using the USPTO database and was measured as the number of patents that were approved in year *t*.

Alliances. Alliances were included because of the potential impact they can have on a firm's performance in a number of ways. First of all, Yli-Renko and Janakiraman (2008) have shown how a firm's set of partners can influence its new product development processes. Secondly, an organization's propensity to change can also be modified by its relationships with other organizations (Dobrev et al., 2003). We measured the total number of alliances a firm had established from its founding till the end of the year under study (for hypotheses 2-4), or the total number of alliances a firm had established from its founding till the end of 2013 in the analysis of hypothesis 1. We calculated alliance data on the basis of press releases, company websites and industry reports and included all alliances of the following types: R&D, outside investor, clinical trials/evaluation, manufacturing, marketing/licensing, supply/distribution and investment/joint venture (Powell, Koput, & Smith-Doerr, 1996).

Time controls. Year dummies were included to control for period effects, such as differences in macroeconomic conditions or industry opportunities that may have occurred during the period of

interest and that may have influenced the impact of firms' business model change processes on their performance (Phelps, 2010).

All firms were included in each model from start-up until they were acquired, failed to exist, or until 2014, which was the last year of observation. All variables used in the analysis of hypothesis 1 were cumulative variables, indicating e.g. the total number of patents, product awards etc. that a firm obtained in the period from start-up till the end of 2013. For all other analyses, yearly values were used to indicate the number of patents, product awards etc. that a firm obtained during the year previous to the year of which the performance was analyzed.

4.2.5 Model specification and estimation

In this study, we are interested in analyzing the influence of business model change on several performance variables. To test hypothesis 1, we use all companies and observations to analyze whether firms that changed their business models at least once performed better than firms that did not. For the analysis, we use the total number of products on the market in 2014 as the dependent variable. Since this variable is log-transformed, we used a regular regression model with robust standard errors to test this hypothesis. For the survival analysis, a Cox Proportional-Hazards model with robust standard errors was used.

In the next three hypotheses, we analyze the impact of different business model change processes on performance. For these analyses, we only include the firms that have changed their business models at least once by the end of 2013 (since performance is measured in 2014). However, since firms that have changed their business models may differ from firms that have not changed their business models on certain characteristics that could potentially also influence firms' performance, we control for this using a two-step Heckman selection model (Heckman, 1979). In the first stage

of the Heckman model, we studied the entire set of firms (i.e. 173) and investigated how certain firm characteristics could predict which firms would change their business models and which ones would not. In this first-step model, there needs to be at least one variable that is not included in the second-step model. In this study, the additional variables included in the first-step Heckman model are the management team size, whether or not the firm is VC-backed, the cumulative number of FDA approvals, product awards and patents, the total number of alliances a firm has established and year controls. Based on this first-stage probit regression, we then calculated an adjustment term, the inverse Mills ratio, which we then included as a control variable in the second-step analyses (Heckman, 1979). In this second step, we then analyzed to what extent different business model change processes (i.e. different degree of change and time between changes) can have an impact on new ventures' performances. Only the 57 firms that changed their business models before or in 2013 were included in this second step. For the number of new product introductions, we used a random-effects panel regression model with robust standard errors. For the survival analysis, we used a Cox Proportional-Hazards model with robust standard errors. In all analyses, we investigated the influence of the independent and control variables' values in year *t-1* on the firm's performance or survival status in year *t* (e.g. Phelps, 2010).

5.3 Results

Table 5.1 presents the descriptive statistics and correlation matrix for the two sets of analyses. Panel A contains information on the full sample of 173 firms that was used to test hypothesis 1. Panel B summarizes the descriptive statistics and correlations of the 57 firms included in the second set of analyses, used to test hypotheses 2-4.

Table 5.1 – Descriptive statistics and correlation tables

Panel A – First-step models

	Mean	Std. Dev.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.
1. Products on market in year *t* (log)	1.11	0.71	1																		
2. External funding (cumulative) in year *t* (log)	7.07	3.53	-0.02	1																	
3. Active at end of year *t* (dummy)	0.8	0.4	0.01	0.18*	1																
4. Acquired at end of year *t* (dummy)	0.18	0.39	0.02	-0.19**	-0.93**	1															
5. Failed at end of year *t* (dummy)	0.03	0.16	-0.09	0.03	-0.25**	-0.08	1														
6. Sector: Medical	0.18	0.38	-0.08	0	-0.01	0.04	-0.08	1													
7. Sector: Administrative	0.3	0.46	-0.07	0.1	0.04	-0.01	-0.11	-0.30**	1												
8. Firm age	5.13	2.09	0.19**	0.08	0.17*	-0.14	-0.11	0.21**	0.07	1											
9. Products on market in year *t-1* (log)	1.02	0.65	0.95**	0.01	-0.01	0.03	-0.07	-0.11	-0.06	0.21**	1										
10. Technical experience	0.55	0.42	-0.01	0.08	-0.09	0.06	0.12	0.05	0.09	-0.16*	0.01	1									
11. Market experience	0.43	0.43	-0.12	0.07	-0.01	0	0.07	6	0.12	-0.02	-0.11	-0.10	1								
12. Start-up experience	0.46	0.42	-0.10	0.07	0	-0.02	0.01	-0.11	0.03	-0.13	-0.05	0.15	0.08	1							
13. Management team size (log)	1.38	0.39	0.08	0.27**	0.08	-0.04	-0.03	0.05	-0.04	0.18*	0.08	-0.08	0.15*	0.08	1						
14. VC-backed (dummy)	0.62	0.49	-0.05	0.61**	0.05	-0.03	-0.01	-0.13	0.06	-0.05	-0.01	0.06	-0.08	0.16*	0.26**	1					
15. # FDA approvals (cumulative, log)	0.08	0.27	0.05	-0.03	-0.06	0.08	-0.05	0.49**	-0.11	0.29**	0.05	-0.02	0	0	0.12	-0.12	1				
16. # Patents (cumulative, log)	0.24	0.6	0.09	-0.01	-0.02	0.05	-0.01	0.2**	-0.13	0.41**	0.08	0.08	0.07	0.09	0.18*	-0.06	0.2**	1			
17. # Product awards (cumulative, log)	0.35	0.54	0.12	0.16*	0	0.04	-0.11	0.16*	0.14*	0.31**	0.13	0.08	-0.06	-0.01	0.2**	0.16*	0.27**	0.17*	1		
18. Total # alliances (log)	1.97	0.79	0.25**	0.47**	0.14	-0.1	-0.1	-0.01	0.09	0.36**	0.3**	0.07	0.03	0.12	0.27**	0.36**	0.13	0.21**	0.36**	1	
19. BM changed (dummy)	0.34	0.47	0.26**	0.08	-0.01	0.02	0.02	0.06	-0.08	0.21**	0.24**	-0.03	0.01	0.08	0.14	0.02	0.13	0.23**	0.23**	0.35**	1

Values for variables 1 till 5 are for year *t* , all other variables' values are for year *t-1*
** p<0.01, *p<0.05, n=173

Panel B – Second-step models

	Mean	Std. Dev.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.
1. # New products introduced in year *t*	0.33	0.43	1													
2. Active at end of year *t* (1/0)	0.96	0.19	-0.05	1												
3. Acquired at end of year *t* (1/0)	0.03	0.18	0.03	-0.96**	1											
4. Failed at end of year *t* (1/0)	0.01	0.09	0.01	-0.19**	-0.01	1										
5. Sector: administrative	0.25	0.44	-0.03	-0.06	0.07	-0.05	1									
6. Sector: medical	0.24	0.43	-0.01	0.04	-0.03	-0.05	-0.33**	1								
7. Firm age	3.15	2.34	0.13*	-0.08	0.07	0.04	-0.04	0.15**	1							
8. Products on market (log)	0.92	0.62	0.28**	-0.14**	0.14*	0.01	-0.05	0.12*	0.49**	1						
9. External funding cumulative (log)	4.37	4.5	0.22**	-0.03	0.01	0.12*	0.07	-0.04	0.46**	0.35**	1					
10. Technical experience	0.53	0.43	0.1	-0.06	0.04	0.11	-0.03	-0.06	-0.02	0.1*	0.03	1				
11. Market experience	0.44	0.44	0.06	0.03	-0.02	0.05	0.16**	0.24**	0.02	-0.02	0.02	-0.2**	1			
12. Start-up experience	0.49	0.41	0.08	0	0	-0.08	-0.04	-0.08	-0.02	-0.04	0	0.22**	0.22**	1		
13. Degree of BM change	0.23	0.48	-0.02	-0.12*	0.09	0.04	0.02	-0.07	0.09	0.11*	0.24**	-0.03	0.01	-0.01	1	
14. Time since BM change	1.91	1.53	0.04	-0.01	-0.01	0.03	-0.07	0.18**	0.59**	0.24**	0.17**	-0.08	0.06	-0.03	0.19**	1

n = 357
Values for 1 and 2 are for year *t* , all other variables' values are for year *t-1*
** p<0.01, *p<0.05

Panel A shows that, in the last year of observation, firms on average had 1.11 products on the market and 7070 dollar external funding raised (logged values). About 80% of the firms were still active at the end of 2014 (i.e. the final year of observation), 18% of firms were acquired and the remainder of firms had failed. About 20% of firms were active in the medical segment, 30% in the administrative segment and the remainder of the companies in the fitness & wellness segment (i.e., the reference category). Firms, on average, were 5.13 years old. The average founding team contains 55% of members with previous technical experience, 43% of members with market experience and 46% of members with start-up experience. Most firms (62%) were VC-backed in the last year of observation and about 34% of the firms had changed their business models at least once in the period from start-up till the end of 2013. The business model change dummy is positively correlated to the number of products on the market, but is not significantly correlated to any of the other performance outcomes (i.e. acquisition, failed or active status).

Panel B shows the correlations and descriptive statistics for those firms that had changed their business models at least once. The average degree of business model change was 0.23 and the average time since business model change was 1.91 years. The value of 0.23 represents the average degree of business model change that firms undertook during their various business model changes (if applicable), but also includes the years during which firms did not undertake business model changes. In other words, when only looking at the years with business model changes, the average degree of business model change would take on higher values.

The table further shows some relatively high correlation values between some of the independent and control variables. The correlations between being active in the medical segment and the number of FDA approvals, for example is 0.49 in panel A, while the correlation between time since last business model change and firm age in panel B is 0.59. However, the highest mean VIF

obtained in any of the models was 1.70 and the highest individual VIF for a single variable was 3.31. These values are all lower than the rule-of-thumb cutoff of 10 (Ryan, 1997), thereby suggesting that multicollinearity is not necessarily an issue in our analyses. All explanatory variables were standardized prior to calculating the interaction terms and prior to entering them into the model.

5.3.1 First-stage estimates: Impact of having changed business model on performance

Table 5.2 then shows the results for the analysis of whether firms that had changed their business models at least once by 2013 had a higher performance in 2014. The analysis consisted of a regular regression analysis using Hubert-White robust standard errors. The table includes the results for both the number of products on the market and the survival and acquisition status of the firm. The first half of the survival analysis uses "cease to exist as an independent venture" as the dependent variable, thus lumping together firms that failed and firms that got acquired. The second half of the survival analysis predicts which firms are likely to get acquired. Due to the low number of firms failing (n = 5), it was not possible to run an additional analysis with "failure" as dependent variable.

The first model each time represents the control variable model. When looking at the number of products on the market as the dependent variable, we can see that the sector dummies have a significant impact. Both firms in the administrative and medical segment have fewer products on the market than firms in the fitness & wellness segment. Moreover, firms with more alliances will have more products on the market. For the first survival analysis, technical experience makes it more likely for firms to cease to exist as an independent venture, while having more alliances has the opposite effect. For the second survival analysis, finally, having more funding makes it less

likely to be acquired, whereas being VC-backed and having more technical experience makes it more likely to be acquired.

When including the independent variable, i.e. the dummy that indicates whether firms ever changed their business models or not, we can see that this variable only has a significant impact on the number of products on the market. In this case, having changed your business model at least once as a new venture, has the consequence of having more products on the market later on in the lifetime of the new venture. It does not increase or decrease the chances of ceasing to exist as an independent venture or of getting acquired, however. As a result, we only find partial support for hypothesis 1.

5.3.2 Heckman selection model

Table 5.3 below presents the results of the first-stage Heckman selection model, which was a panel data probit regression of the likelihood of engaging in business model change behavior. The dependent variable was the dummy variable of whether or not a firm had engaged in business model change behavior in the period between its founding year (the oldest firms in the sample were founded in 2005) and 2013. The table shows that only firm age and some of the year controls had a significant impact on this likelihood of engaging in business model change behavior. Based on this model, we calculated the inverse Mills ratio, which is included in all subsequent analyses.

Table 5.2 – Regression estimates for first-step model (hypothesis 1)

Regression estimates for impact of BM change on performance

	DV: # Products on market				DV: Survival status: ceasing to exist as independent venture				DV: Survival status: being acquired			
	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6	
Variables	*Coeff.*	*S.e.*	*Coeff.*	*S.e.*	*Hazard ratio*	*S.e.*	*Hazard ratio*	*S.e.*	*Hazard ratio*	*S.e.*	*Hazard ratio*	*S.e.*
Intercept	0.44	0.28	0.45	0.28								
Firm age	0.04	0.03	0.04	0.04								
Sector:												
- Administrative	-0.21†	0.13	-0.19	0.13	0.61	0.28	0.63	0.3	0.81	0.37	0.83	0.4
- Medical	-0.34*	0.17	-0.34*	0.16	0.81	0.52	0.81	0.52	1.12	0.71	1.11	0.71
# Products on market (log)					0.95	0.25	0.93	0.25	1.01	0.27	1	0.27
Amount of external funding raised (cumulative, log)	0	0.02	0	0.02	0.93	0.05	0.93	0.05	0.89*	0.05	0.89*	0.05
Technical experience	0.02	0.06	0.03	0.06	1.58*	0.33	1.59*	0.33	1.46†	0.31	1.47†	0.31
Market experience	-0.08	0.05	-0.08	0.05	1.18	0.23	1.17	0.23	1.16	0.23	1.16	0.23
Start-up experience	-0.07	0.05	-0.08	0.05	1.02	0.2	1	0.2	0.95	0.19	0.94	0.2
Management team size (log)	0.17	0.16	0.17	0.16	0.84	0.45	0.84	0.46	0.86	0.49	0.87	0.49
VC-backed (dummy)	-0.24	0.15	-0.22	0.15	2.06	0.97	2.09	0.98	2.86*	1.32	2.89*	1.34
# FDA approvals (cumulative, log)	0.02	0.23	0.01	0.22	0.87	0.87	0.88	0.88	0.85	0.8	0.86	0.81
# Product awards (cumulative, log)	0.05	0.13	0.03	0.14	0.96	0.4	0.94	0.38	0.94	0.39	0.92	0.38
# Patents (cumulative, log)	-0.02	0.14	-0.04	0.14	0.56	0.23	0.54	0.23	0.61	0.23	0.6	0.23
# Alliances (cumulative, log)	0.22*	0.09	0.19*	0.09	0.54*	0.16	0.53*	0.16	0.62	0.19	0.61	0.19
Business model change (dummy)			0.2†	0.12			1.21	0.54			1.17	0.56
R-squared	0.15		0.17									
Pseudo log likelihood					-134.77		-134.66		-122.39		-122.33	
F	2.03*		2.28**									

***p<0.001, ** p<0.01, * p<0.05, † p<0.1

DV was measured in year t, all other variables were measured in year t-1, n=173

Coefficients for survival analysis are hazard rates

Grey cells indicate that variable was not included in model

Table 5.3 – Probit estimates for Heckman selection model

Probit estimates for Heckman selection model: DV = Business model changed by year 2013 (1/0)

Variables	*Coeff.*	*S.e.*
Intercept	-5.07***	1.18
Firm age	0.51**	0.18
Sector:		
- Administrative	-0.89	0.68
- Medical	-0.19	0.81
# Products on market (log)	0.06	0.37
Amount of external funding raised (cumulative, log)	0	0.07
Technical experience	-0.04	0.31
Market experience	0.01	0.31
Start-up experience	0.44	0.31
Management team size (log)	0.4	0.64
VC-backed (dummy)	0.05	0.53
# FDA approvals (cumulative, log)	0.01	0.96
# Product awards (cumulative, log)	0.66	0.49
# Patents (cumulative, log)	0.71	0.6
# Alliances (cumulative, log)	0.18	0.32
Time controls		
- 2005	5.35**	1.6
- 2006	4.89***	1.26
- 2007	4.43***	1.1
- 2008	3.8***	0.94
- 2009	3.05***	0.79
- 2010	2.3**	0.67
- 2011	1.49**	0.54
- 2012	0.71	0.45
Log likelihood	-152.56	

***p<0.001, ** p<0.01, * p<0.05, ŧ p<0.1
DV was measured in year t, all other variables were measured in year t-1

5.3.3 Second-stage estimates: Impact of business model change processes on performance

Table 5.4 below includes the second stage estimates of the impact of business model change processes on new product development as the measure of performance. Table 5.6 includes the analyses for the survival analysis with ceasing to exist as an independent venture (i.e. getting acquired or failing) and getting acquired as dependent variables. The analyses for new product

development use random-effects panel data regressions with robust standard errors, while the survival analyses use Cox Proportional-Hazards models with robust standard errors.

We chose to use a random-effects rather than a fixed-effects model for a number of reasons. First of all, in this study, it makes sense to take advantage of between-unit variance, such as differences in business model changes across firms, rather than only within-unit variance, e.g. over time, since we expect that firms will vary in their business model change behavior (Schilling, 2015). Second, a fixed effects model does not allow estimation of coefficients for time-invariant regressors, such as firm segment or founding team experience variables (Jiang, Tan, & Thursby, 2011). Moreover, in our models, we controlled for the total number of products on the market in year *t-1* when predicting the number of new products introduced on the market in year *t.* This control variable captures previous firm behavior with regards to introducing new products and thus forms a strong firm-level control that should pick up much of the potential firm-specific time-invariant effects on new product development, thus warranting our choice for a random-effects, rather than a fixed-effects model (Jiang et al., 2011; Schilling, 2015).

DV1: New product development

The "controls only" model in Table 5.4 shows that the amount of external funding available to a firm has a positive impact on the number of new products introduced in the next year. When looking at the second model, which includes the independent variables, we can see that the degree of business model change has a significant negative impact on the number of new products introduced in the subsequent years. Time since last business model change does not have a significant impact. Based on these results, we thus find support for hypothesis 2, but not for hypothesis 3. The third model then includes the interaction effect between degree of business model change and time since last business model change, which is significant and positive.

Table 5.4 – Second-step regression estimates for impact of BM change on new product development

Regression estimates for impact of BM change on performance

	DV: # New products introduced into market in year *t*					
	Model 1		Model 2		Model 3	
Variables	*Coeff.*	*S.e.*	*Coeff.*	*S.e.*	*Coeff.*	*S.e.*
Intercept	0.09	0.07	0.07	0.08	0.04	0.08
Inverse Mills Ratio	0.06†	0.03	0.08*	0.03	0.08**	0.03
Firm age	0.02	0.01	0.01	0.02	0.02	0.02
Sector:						
- Administrative	-0.06	0.08	-0.07	0.08	-0.07	0.08
- Medical	0.01	0.09	0	0.09	0	0.09
# Products on market (log)	0.06	0.07	0.08	0.07	0.08	0.07
Amount of external funding raised (cumulative, log)	0.01†	0.01	0.02*	0.01	0.02*	0.01
Technical experience	0.04	0.03	0.03	0.03	0.03	0.03
Market experience	0.03	0.04	0.03	0.04	0.02	0.04
Start-up experience	0.04	0.04	0.05	0.04	0.05	0.04
Degree of BM change (log)			-0.07**	0.02	-0.08***	0.02
Time since BM change			0.03	0.03	0.02	0.03
Degree of BM change X Time since BM change					0.04**	0.02
R-squared	0.11		0.13		0.14	
χ^2	27.80**		39.41***		41.64***	

***p<0.001, ** p<0.01, * p<0.05, † p<0.1
DV was measured in year t, all other variables were measured in year t-1, n(firms) = 57, n(observations) = 327
All standard errors are robust standard errors

Figure 5.2 below graphically plots this interaction effect. It shows that for firms that have undertaken a more incremental business model change (low degree of business model change), the impact of time since last business model change does not seem to have a big impact. However, when undertaking a more radical business model change (high degree of business model change), the performance of the firm, measured as the number of new products introduced on the market in the subsequent year, will be higher when it has been a longer time since the last business model change. In other words, the results find support for the fact that the time since last business model change mitigates the relation between degree of business model change and new product development. As such, we find support for hypothesis 4.

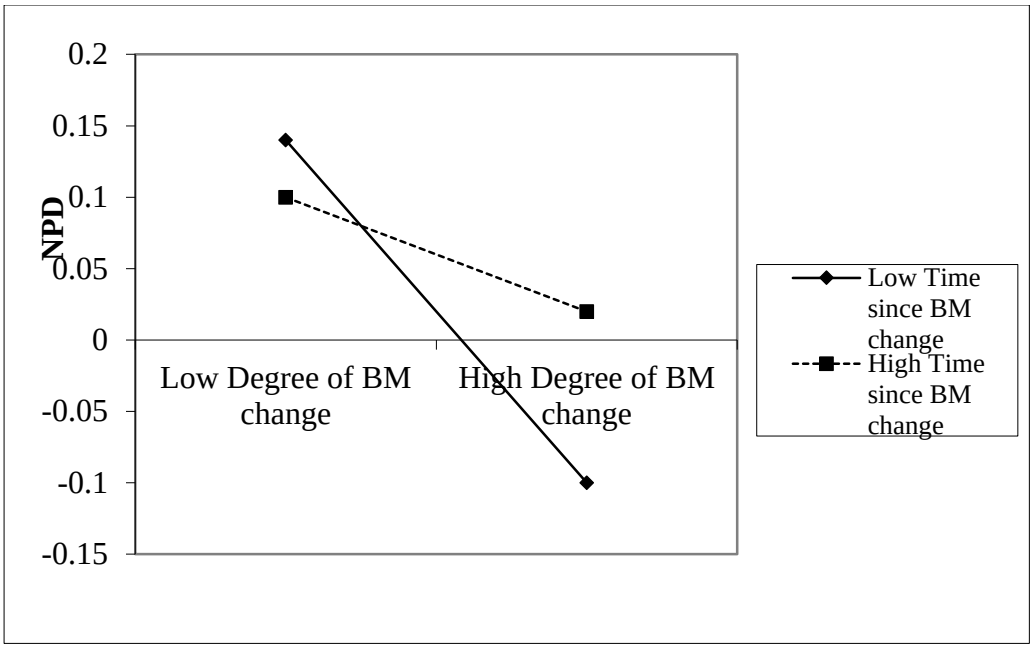


Figure 5.2 – Two-way interaction effect between degree of business model change and time since last business model change

DV2: Survival

Table 5.5 contains the results of the survival analysis. Two different dependent variables were used. The first one measures failure as either being acquired or as a failing venture. In other words, all ventures that cease to exist as an independent venture are included in this failure variable. The second set of analyses only looks at firms that got acquired as the "failure event". Due to the low number of failed firms that had also changed their business models (n=3), it was not possible to run the analyses with failure as the outcome variable.

Table 5.5 – Second-step regression estimates for survival analyses with "ceasing to exit as independent venture" and "likelihood of being acquired" as dependent variables

Regression estimates for impact of BM change on performance

	DV: Ceasing to exist as independent venture						DV: Acquisition					
	Model 1		Model 2		Model 3		Model 1		Model 2		Model 3	
Variables	*Hazard ratio*	*S.e.*	*Hazard ratio*	*S.e.*	*Hazard ratio*	*S.e.*	*Hazard ratio*	*S.e.*	*Hazard ratio*	*S.e.*	*Hazard ratio*	*S.e.*
Inverse Mills Ratio	0.96	0.45	0.97	0.45	0.97	0.45	0.98	0.54	0.83	0.48	0.82	0.47
Sector:												
- Administrative	2.08	1.49	2.46	1.58	2.48	1.63	3.01	2.28	3.43†	2.51	3.49†	2.54
- Medical	0.76	0.63	0.77	0.72	0.77	0.72	0.69	0.5	0.57	0.45	0.58	0.44
# Products on market (log)	2.09*	0.79	2.18*	0.83	2.22*	0.85	2.27†	1.03	2.32†	1.09	2.3†	1.08
Amount of external funding raised (cumulative, log)	0.97	0.08	0.91	0.1	0.92	0.1	0.91	0.07	0.88†	0.07	0.88†	0.07
Technical experience	1.38	0.58	1.46	0.69	1.42	0.66	1.22	0.53	1.31	0.59	1.29	0.57
Market experience	0.86	0.3	0.83	0.26	0.81	0.26	0.93	0.39	0.97	0.39	0.96	0.38
Start-up experience	0.98	0.43	0.97	0.39	0.96	0.39	0.99	0.57	0.85	0.48	0.84	0.47
Degree of BM change (log)			1.75*	0.38	1.72*	0.44			0.52	0.26	0.56	0.26
Time since BM change			0.67	0.36	0.57	0.38			0.21**	0.13	0.23**	0.12
Degree of BM change X Time since BM change					1.16	0.38					1.59	0.6
χ^2	9.73		31.66***		41.25***		8.01		23.31**		48.78***	

***p<0.001, ** p<0.01, * p<0.05, † p<0.1

DV was measured in year t, all other variables were measured in year t-1, n(firms) = 57, n(observations) = 373

All standard errors are robust standard errors

The first models only include control variables. For both dependent variables, having more products on the market increases the risk of ceasing to exist as an independent venture or of being acquired. In the second model, the independent variables are then added. In the first set of models, the degree of business model change significantly increases the risk of ceasing to exist as an independent venture, thereby supporting hypothesis 2. For the second set of models, in which acquisition status is predicted, degree of business model change does not have a significant impact, but time since last business model change does. The results show that the longer it has been since the last business model change, the less likely the venture will be acquired, thereby finding the opposite result of what was predicted in hypothesis 3. The third model then adds the interaction effect between degree of business model change and time since last business model change, which was not significant in either of the two models. As a result, we did not find support for hypothesis 4.

Table 5.6 below summarizes the findings for all four hypotheses for the three different dependent variables that were used in this study.

Table 5.6 – Overview of supported hypotheses per dependent variable

	Products on market/new product development	***Survival: Cease to exist as independent venture***	***Survival: Acquired***
H1: Impact BM change on performance	Supported	Not supported	Not supported
H2: Impact degree of BM change on performance	Supported	Supported	Not supported
H3: Impact "time since BM change" on performance	Not supported	Not supported	Not supported: opposite effect found
H4: Interaction: degree of BM change X time since BM change	Supported	Not supported	Not supported

5.4 Discussion

Organizational change processes and their implications have often been studied in the context of established ventures, either active in established industries, or responding to disruptions in their environments (Ambos & Birkinshaw, 2010). However, every established organization once started out as a new venture, and a significant number of established industries were once emerging industries. As a result, it is important to know how new ventures, active in emerging industries, evolve and how their organizational change processes have implications for their performance. Typical for new ventures in uncertain environments is the fact that they are not mainly driven by long-term goals such as profitability, but by more short-term goals such as launching a new product on the market and surviving (Ambos & Birkinshaw, 2010; Graebner, 2004).

In response to this underresearched contingency of new ventures in an emerging industry, we investigated the impact of these new ventures' organizational change processes on their performance. We conceptualized organizational change as business model change in this study and analyzed how the degree of business model change, as well as the time in between business model changes, influenced new ventures' performance.

5.4.1 Implications for organizational change literature

Our results mainly make contributions to the organizational change literature. First of all, our study is one of the few that focuses on organizational change processes in new ventures in emerging industries. Most previous studies focused on established ventures in a mature industry that undertook organizational changes in light of an industry disruption by a new entrant. New ventures are different from established ventures, though. For example, they have limited financial, technological and human resources and little power over other actors (Ambos & Birkinshaw,

2010), which makes them more concerned by short-term survival than longer-term survival. Moreover, emerging industries are also characterized by a lot of uncertainty, because of, among others, the lack of dominant design, unclear or missing product definitions (Santos & Eisenhardt, 2009). As such, it is unlikely that the organizational change processes of new ventures in emerging industries will be similar to those of established ventures in more mature industries.

Despite the differences between our setting and the predominant setting of established ventures in mature industries, our findings are surprisingly similar to those found in this setting of established ventures in mature industries. For example, we have found that the degree of business model change has a negative impact on performance for two out of the three performance indicators. This is in line with the findings by Dobrev et al. (2003) and Hannan and Freeman (1989) who have shown that the complexity of change increases the mortality of the change, and thus that more radical changes have a negative impact on performance.

Moreover, we have found that firms that had changed their business models at least once had a higher performance, measured by their new product development. This finding supports the notion in the organizational change literature that inertia, or lack of change, has a negative impact on a firm's performance (Dobrev et al., 2003). However, our finding that firms that have changed their business models outperform firms that have not changed their business models was not supported when looking at the survival status as outcome variables, even though new product development is often seen as a factor contribution to a firm's survival (Katila & Ahuja, 2002; Yli-Renko & Janakiraman, 2008). It is possible that new product development is mediating the relationship between business model change and survival. Another possible explanation could be that the sampling period of nine years was too short to witness a significant relation between having

changed one's business model and having a different survival status, i.e. ceasing to exist as independent venture or being acquired.

A third result that was surprisingly similar to the existing organizational change literature on established ventures in mature industries was the fact that continuous, incremental change and discontinuous, radical change processes were the highest performing combinations between degree of business model change and time since last business model change. These are the two combinations that have received the most attention in the organizational change literature (e.g. Brown and Eisenhardt (1997) and Rindova and Kotha (2001) for continuous, incremental change and Tushman and Anderson (1986) and Tushman and Romanelli (1985) for discontinuous, radical change). On the other hand, this was finding was not confirmed for the other two dependent variables, so these two types of organizational change may not uniformly be the best for all performance indicators. A possible explanation as to why this interaction effect was not significant for the two survival analyses is the fact that a longer time since last business model change means that the firm has existed longer, meaning that the firm has not failed or has not been acquired. As such, the advantage of a shorter time since last business model change that is present in the case of continuous, incremental change may be outbalanced by the fact that a longer time since last business model change equals a longer survival time of the firm.

The hypothesized negative effect of time since last business model change was not found for any of the dependent variables. On the contrary, the opposite effect was found for the survival analysis with acquisition status as dependent variable. The results show that firms have a lower likelihood of being acquired as it has been longer since they last changed their business models. This unexpected finding could potentially be caused by the previously mentioned fact that firms that

have not changed their business models in a long time have also survived for this longer amount of time.

Our final contribution to the organizational change literature lies in digging deeper into the impact of degree of organizational change on performance, which was suggested as a future research avenue by Furr et al. (2012).

5.4.2 Implications for entrepreneurship literature

Our study also makes contributions to the entrepreneurship literature. By focusing on new ventures' early change processes and the implications thereof on performance, we gain more insights into how new ventures come into being, how they evolve and how this impacts their performance and survival. As such, our study contributes to the growing stream of recent studies (Ambos & Birkinshaw, 2010; Furr et al., 2012) that focuses on change processes in new ventures, be it organizational (Ambos & Birkinshaw, 2010) or technological (Furr et al., 2012).

In addition, our study contributes to the entrepreneurship literature by focusing on the organizational change processes of new ventures in emerging industries, an underresearched contingency. Our results have shown that the performance implications of new ventures' organizational change processes in emerging industries are relatively similar to those of established ventures in more established industries. Moreover, our results have shown that the performance implications of having changed one's business model are surprisingly limited. Given the importance of business model change in new ventures (Blank, 2013) and emerging industries (Teece, 2010), we expected that the performance would differ more significantly between ventures that have and have not changed their business models. However, our results show that only the number of products on the market is significantly higher in the context of ventures that had changed

their business models and that the survival of the ventures is not impacted by this business model change.

5.4.3 Implications for business model literature

By focusing on new ventures' business model changes, our study also contributes to the business model literature. Few studies have focused on the implications of business model change or experimentation on performance, and most studies that have addressed this topic (e.g. Andries et al. 2013; Sosna, Trevinyo-Rodriguez, & Velamuri, 2010) adopted a case-study approach. Our study is one of the first large-scale studies on business models and their implications on performance.

Moreover, we contribute to the business model literature by showing the different outcomes that business models can have an impact on. Most previous studies on the impact of business models on performance focused on variables such as stock-market value (Zott & Amit, 2007, 2008) or profit (Brea-Solis, Casadesus-Masanell, & Grifell-Tatje, 2015), which are outcome variables that are less relevant for new ventures (Ambos & Birkinshaw, 2010). Our results show that business models, or changes thereof, also have direct implications for new product development and survival as independent ventures.

Additionally, our study has extended the work by Andries et al. (2013), who focused on two specific business model change processes, i.e. simultaneous experimentation and focused commitment. We extended their study by looking at the degree of change and time since last business model change both separately and jointly, thereby allowing us to look at all possible types of business model change processes and the potential impact they have on the performance of new ventures in an emerging industry.

5.5 Implications for practitioners

Our study also offers some more practical implications. First of all, by focusing on different aspects of business model change processes and their performance implications, our study provides useful insights for entrepreneurs, active in new ventures in emerging industries. Our results provide the knowledge that firms that have changed their business models will have more products on the market than firms that have not. While change for the sake of change will probably not have this same beneficial effect for new ventures, entrepreneurs doubting whether or not to undertake a business model change may feel inspired to do so, knowing that there will be no long-term negative effects of undertaking change. While only the firm's new product development processes benefit from having changed the firm's business model, there are no negative implications with regards to the other performance variables. Moreover, our study has shown that more radical business model change will have negative implications for new product development and survival as an independent venture. Entrepreneurs should thus be aware that their performance will suffer from more radical business model changes in the year after their business model. Moreover, our study only finds partial support for the notion that continuous, incremental improvement and disruptive, radical change are beneficial for performance. While this finding is supported for the new product development, it was not for the other outcome variables. Entrepreneurs should thus not feel constrained by the dominant perspectives of change, as their ability to survive as an independent venture will not suffer from undertaking disruptive, incremental change instead of continuous, radical change, all other things equal. On the other hand, our results also show that ventures are less likely to be acquired if it has been a longer time ago that they last changed their business models. For firms that want to remain independent, it can be interesting to know that changes in

their business model will more likely make them a target, and going without a business model change for a longer time decreases their likelihood of being acquired.

Our findings are also relevant to policymakers. By gaining more insights in the organizational change mechanisms of new ventures, government agencies and accelerators can help these ventures in undertaking their organizational change processes. Moreover, they can try to alleviate some of the negative performance implications of business model change by, for example, giving the companies that undertake change financial incentives that help support their new product development processes or that can act as financial buffers that can protect the firms against potential takeover bids. Like this, the government can help new ventures that are willing to change their business models help remain independent and help them work on their new product development, which are some dimensions that are likely to suffer in the year after a business model change.

Finally, our findings are also relevant to venture capitalists and other financiers. Venture capitalists sometimes prohibit ventures to deviate from their initial business plans, as they view this change as an indication that the initial business plan was poorly executed, rather than as a sign of the changing environment and the learning the venture has undertook since founding (Andries et al., 2013; Clarysse, Wright, & Pauwels, 2015). The findings of this study show that there are no negative long-term implications of business model change on performance. On the contrary, business model change has a positive impact on the new product development processes of new ventures. As a result, the findings of our study could teach VCs that change is not necessarily bad and that they should support their portfolio companies who want to undertake such changes.

5.6 Limitations and future research implications

Several limitations in the current study provide avenues for future research. First of all, one of the dependent variables used in this study is whether or not a firm gets acquired. This includes firms that got acquired because they were successful and wanted to use a trade sale as an exit mechanism (Bayar & Chemmanur, 2012), but also firms that were unsuccessful and consequently got acquired. By consequence, the results of the analyses with this dependent variable are hard to interpret, as there is no way to distinguish between the successful and unsuccessful firms and the reasons they got acquired in this study. As such, the results with acquisition status as outcome should only be viewed in comparison with the results of the analyses with "cease to exist as independent venture" as outcome variable, which includes both acquisitions and failures. By comparing the two sets of results, we can get some insights into how business model changes differentially impact acquisitions and failures. To address this limitation, future research could investigate the link between business model changes, acquisitions, and the success and/or willingness of the venture to get acquired.

Secondly, the period of analysis of this study is rather short, i.e. from 2005 to 2014, meaning that the oldest firms from the sample were nine years at the end of the sampling period. It is possible that the lack of significant results for some of the hypotheses with regards to the "cease to exist as independent venture" and "acquisition" status dependent variables are due to this rather short period of time, as it is possible that some of the ventures of our sample will get acquired or will fail in a few years. As such, future research could use a longer sampling period to address this limitation of our study and to investigate whether business model changes have a longer term impact on the likelihood of ceasing to exist as an independent venture or getting acquired.

Thirdly, even though we adopted a lagged effect in our study to ensure that reversed causality and simultaneity were not present in our study, our results cannot prove the causality between business

model change and new venture performance. In future studies, researchers could conduct interviews with some firms to gain deeper insights into whether or not a causal link between business model changes and performance is present.

Fourth, due to our focus on new ventures in the emerging mobile health industry, our results may not be generalizable to other industries or to new ventures that are not active in emerging industries. While all of the measures used in this study are not specific to the mHealth industry, it is nevertheless possible that our findings are not generalizable to other industries. Future studies could thus investigate the impact of business model change in other industries and see whether our findings hold in this different context. Moreover, our sample is heavily biased towards the US mHealth industry, with only 4.3% of the firms being from other countries. Our findings may thus not be generalizable to other countries, which is a topic that could be studied in future studies.

Fifth, our analyses only focused on investigating the impact of having changed one's business model, the degree of business model change and the time since business model change on new ventures' performance. It was not our intention to focus on whether specific types of changes, such as changes in value proposition or internal capabilities have equal implications on new ventures' performance. This is a topic that could be addressed in future studies on the performance implications of business model changes.

Finally, we used new product development and likelihood of ceasing to exist as an independent venture and likelihood of being acquired as performance indicators. While these indicators have been used in previous studies, they can only be seen as proxies of new ventures' performance. Future studies using primary data could address this gap by looking at customer adoption or revenues as more direct measures of new venture performance.

5.7 References

Aldrich, H. & Auster, E. R. 1986. Even dwarfs started small: Liabilities of age and size and their strategic implications. In B. M. Staw & L. L. Cummings (Eds.), ***Research in organizational behavior***, Vol. 8: 165-198. Greenwich, CT: JAI Press.

Ambos, T. C. & Birkinshaw, J. 2010. How do new ventures evolve? An inductive study of archetype changes in science-based ventures. ***Organization science***, 21(6): 1125-1140.

Amis, J., Slack, T., & Hinings, C. R. 2004. The pace, sequence, and linearity of radical change. ***Academy of Management Journal***, 47(1): 15-39.

Andries, P., Debackere, K., & Van Looy, B. 2013. Simultaneous Experimentation as a Learning Strategy: Business Model Development Under Uncertainty. ***Strategic Entrepreneurship Journal***, 7(4): 288-310.

Bayar, O. & Chemmanur, T. J. 2012. IPOs versus acquisitions and the valuation premium puzzle: a theory of exit choice by entrepreneurs and venture capitalists. ***Journal of Financial and Quantitative Analysis***, 46(06): 1755-1793.

Battilana, J. & Casciaro, T. 2012. Change Agents, Networks, and Institutions: A Contingency Theory of Organizational Change. ***Academy of Management Journal***, 55(2): 381-398.

Beck, N., Bruderl, J., & Woywode, M. 2008. Momentum or deceleration? Theoretical and methodological reflections on the analysis of organizational change. ***Academy of Management Journal***, 51(3): 413-435.

Bingham, C. B. & Davis, J. P. 2012. Learning sequences: their existence, effect, and evolution. ***Academy of Management Journal***, 55(3): 611-641.

Blank, S. 2013. Why the lean start-up changes everything. ***Harvard Business Review***, 91(5): 63-72.

Bohnsack, R., Pinkse, J., & Kolk, A. 2014. Business models for sustainable technologies: Exploring business model evolution in the case of electric vehicles. ***Research Policy***, 43(2): 284-300.

Brea-Solis, H., Casadesus-Masanell, R., & Grifell-Tatje, E. 2015. Business Model Evaluation: Quantifying Walmart's Sources of Advantage. ***Strategic Entrepreneurship Journal***, 9(1): 12-33.

Brown, S. L. & Eisenhardt, K. M. 1997. The art of continuous change: Linking complexity theory and time-paced evolution in relentlessly shifting organizations. ***Administrative science quarterly***: 1-34.

Burke, M. J. & Dunlap, W. P. 2002. Estimating interrater agreement with the average deviation index: A user's guide. ***Organizational Research Methods***, 5(2): 159-172.

Chesbrough, H. & Rosenbloom, R. S. 2002. The role of the business model in capturing value from innovation: evidence from Xerox Corporation's technology spin-off companies. ***Industrial and Corporate Change***, 11(3): 529-555.

Clarysse, B., Wright, M., & Pauwels, C. 2015. Business Model Pivoting in New Ventures: a Resource Management Perspective. ***Working paper***.

DiMaggio, P. J. 1991. Constructing an organizational field as a professional project: US art museums, 1920-1940. ***The new institutionalism in organizational analysis***: 267-292.

Dobrev, S. D., Kim, T. Y., & Carroll, G. R. 2003. Shifting gears, shifting niches: Organizational inertia and change in the evolution of the US automobile industry, 1885-1981. ***Organization Science***, 14(3): 264-282.

Eisenhardt, K. M. 1989. Making fast strategic decisions in high-velocity environments. ***Academy of Management journal***, 32(3): 543-576.

Furr, N. R., Cavarretta, F., & Garg, S. 2012. Who changes course? The role of domain knowledge and novel framing in making technology changes. ***Strategic Entrepreneurship Journal***, 6(3): 236-256.
Gagliardi, P. 1986. The creation and change of organizational cultures: A conceptual framework. ***Organization studies***, 7(2): 117-134.
Gioia, D. A., Schultz, M., & Corley, K. G. 2000. Organizational identity, image, and adaptive instability. ***Academy of management Review***, 25(1): 63-81.
Graebner, M. E. 2004. Momentum and serendipity: How acquired leaders create value in the integration of technology firms. ***Strategic management journal***, 25(8-9): 751-777.
Greenwood, R. & Hinings, C. R. 1996. Understanding radical organizational change: Bringing together the old and the new institutionalism. ***Academy of Management Review***, 21(4): 1022-1054.
Haeussler, C., Harhoff, D., & Mueller, E. 2014. How patenting informs VC investors–The case of biotechnology. ***Research Policy***, 43(8): 1286-1298.
Hannan, M. T. & Freeman, J. 1984. Structural inertia and organizational change. ***American sociological review***: 149-164.
Hannan, M. T. & Freeman, J. 1989. Organization ecology: Harvard University Press: Cam bridge.
Hannan, M. T. & Carroll, G. 1992. ***Dynamics of organizational populations: Density, legitimation, and competition***: Oxford University Press.
Hargadon, A. B. & Douglas, Y. 2001. When innovations meet institutions: Edison and the design of the electric light. ***Administrative Science Quarterly***, 46(3): 476-501.
Haunschild, P. R. & Sullivan, B. N. 2002. Learning from complexity: Effects of prior accidents and incidents on airlines' learning. ***Administrative Science Quarterly***, 47(4): 609-643.
Heckman, J. J. 1979. Sample Selection Bias as a Specification Error. ***Econometrica***, 47(1): 153-161.
Hill, C. W. L. & Rothaermel, F. T. 2003. The performance of incumbent firms in the face of radical technological innovation. ***Academy of Management Review***, 28(2): 257-274.
Hoenen, S., Kolympiris, C., Schoenmakers, W., & Kalaitzandonakes, N. 2014. The diminishing signaling value of patents between early rounds of venture capital financing. ***Research Policy***, 43(6): 956-989.
Jiang, L., Tan, J., & Thursby, M. 2011. Incumbent firm invention in emerging fields: evidence from the semiconductor industry. ***Strategic management journal***, 32(1): 55-75.
Kaplan, S. & Tripsas, M. 2008. Thinking about technology: Applying a cognitive lens to technical change. ***Research Policy***, 37(5): 790-805.
Katila, R. & Ahuja, G. 2002. Something old, something new: A longitudinal study of search behavior and new product introduction. ***Academy of management journal***, 45(6): 1183-1194.
Maguire, S., Hardy, C., & Lawrence, T. B. 2004. Institutional entrepreneurship in emerging fields: HIV/aids treatment advocacy in Canada. ***Academy of Management Journal***, 47(5): 657-679.
March, J. G. 1991. Exploration and exploitation in organizational learning. ***Organization Science***, 2: 71-78.
Perry, J. T., Chandler, G. N., & Markova, G. 2012. Entrepreneurial effectuation: a review and suggestions for future research. ***Entrepreneurship Theory and Practice***, 36(4): 837-861.

Phelps, C. C. 2010. A Longitudinal Study of the Influence of Alliance Network Structure and Composition on Firm Exploratory Innovation. ***Academy of Management Journal***, 53(4): 890-913.
Plowman, D. A., Baker, L. T., Beck, T. E., Kulkarni, M., Solansky, S. T., & Travis, D. V. 2007. Radical change accidentally: The emergence and amplification of small change. ***Academy of Management Journal***, 50(3): 515-543.
Polidoro, F. 2013. The Competitive Implications of Certifications: The Effects of Scientific and Regulatory Certifications on Entries into New Technical Fields. ***Academy of Management Journal***, 56(2): 597-627.
Powell, W. W., Koput, K. W., & Smith-Doerr, L. 1996. Interorganizational collaboration and the locus of innovation: Networks of learning in biotechnology. ***Administrative Science Quarterly***, 41(1).
Rao, H., Morrill, C., & Zald, M. N. 2000. Power plays: How social movements and collective action create new organizational forms. ***Research in organizational behavior***, 22: 237-281.
Rindova, V. P. & Fombrun, C. J. 1999. Constructing competitive advantage: The role of firm-constituent interactions. ***Strategic management journal***, 20(8): 691-710.
Rindova, V. P. & Kotha, S. 2001. Continuous "morphing": Competing through dynamic capabilities, form, and function. ***Academy of Management Journal***, 44(6): 1263-1280.
Ryan, T. P. 1997. Modern regression analysis: John Wiley & sons.
Santos, F. M. & Eisenhardt, K. M. 2009. Constructing markets and shaping boundaries: Entrepreneurial power in nascent fields. ***Academy of Management Journal***, 52(4): 643-671.
Sarasvathy, S. D. 2001. Causation and effectuation: Toward a theoretical shift from economic inevitability to entrepreneurial contingency. ***Academy of Management Review***, 26(2): 243-263.
Schilling, M. A. 2015. Technology Shocks, Technological Collaboration, and Innovation Outcomes. ***Organization science***, Forthcoming.
Singh, J. V., House, R. J., & Tucker, D. J. 1986. Organizational change and organizational mortality. ***Administrative Science Quarterly***: 587-611.
Smith, K. G., Collins, C. J., & Clark, K. D. 2005. Existing knowledge, knowledge creation capability, and the rate of new product introduction in high-technology firms. ***Academy of Management Journal***, 48(2): 346-357.
Soh, P.-H. 2003. The role of networking alliances in information acquisition and its implications for new product performance. ***Journal of Business Venturing***, 18(6): 727-744.
Soh, P.-H., Mahmood, I. P., & Mitchell, W. 2004. Dynamic inducements in R&D investment: Market signals and network locations. ***Academy of Management Journal***, 47(6): 907-917.
Sosna, M., Trevinyo-Rodríguez, R. N., & Velamuri, S. R. 2010. Business model innovation through trial-and-error learning: The Naturhouse case. ***Long range planning***, 43(2): 383-407.
Stinchcombe, A. L. 1965. Social structure and organizations. In J. G. March (Ed.), ***Handbook of organizations***: 142-193. Chicago: Rand McNally.
Teece, D. J. 2007. Explicating dynamic capabilities: the nature and microfoundations of (sustainable) enterprise performance. ***Strategic management journal***, 28(13): 1319-1350.
Teece, D. J. 2010. Business models, business strategy and innovation. ***Long range planning***, 43(2): 172-194.
Tushman, M. L. & Romanelli, E. 1985. Organizational evolution: A metamorphosis model of convergence and reorientation. In L. L. Cummings & B. M. Staw (Eds.), ***Research in organizational behavior***, Vol. 7: 171-222. Greenwich, CT: JAI Press.

Tushman, M. L. & Anderson, P. 1986. Technological discontinuities and organizational environments. ***Administrative Science Quarterly***, 31(3): 439-465.
Useche, D. 2014. Are patents signals for the IPO market? An EU–US comparison for the software industry. ***Research Policy***, 43(8): 1299-1311.
Van de Ven, A. H. 1986. Central problems in the management of innovation. ***Management science***, 32(5): 590-607.
Van de Ven, A. H. & Polley, D. 1992. Learning while innovating. ***Organization science***: 92-116.
Yli-Renko, H. & Janakiraman, R. 2008. How customer portfolio affects new product development in technology-based entrepreneurial firms. ***Journal of Marketing***, 72(5): 131-148.
Zott, C. & Amit, R. 2007. Business model design and the performance of entrepreneurial firms. ***Organization science***, 18(2): 181-199.
Zott, C. & Amit, R. 2008. The fit between product market strategy and business model: implications for firm performance. ***Strategic management journal***, 29(1): 1-26.

6. CONCLUSIONS, CONTRIBUTIONS AND FUTURE RESEARCH AVENUES

6. CONCLUSIONS, CONTRIBUTIONS AND FUTURE RESEARCH AVENUES

In this section, I aim to provide some more detailed insights into the key conclusions of this dissertation. I do this by summarizing the main findings and contributions of the different studies in this dissertation, before describing their academic and practitioner contributions. Then, I will discuss the limitations of this dissertation, as well as some future research avenues based on these limitations. Finally, I will end this chapter with a short general conclusion.

6.1 Introduction

The three studies in this dissertation each investigated the phenomenon of business models in a different context. The first study (Chapter 2) was a review of the business model literature. It had a dual role: on the one hand, it served as an overview of the business model literature that was used to identify some of the theoretical and empirical gaps in the research on business models. More importantly, it was also used as a framework that could be used to position the two empirical studies on business model change of this dissertation in the existing business model literature. The second and third study (Chapter 4 and 5) were both empirical studies that used a unique, hand-collected database of new ventures in the emerging mobile health industry. In addition to responding to some theoretical gaps, the large dataset also allowed to address some of the empirical gaps in the business model literature, where most previous studies adopted a case study approach. The second study focused on how experimentation and alliances could explain both the likelihood and the degree of business model change that new ventures in the mobile health industry undertook. The third study, finally, addressed the performance implications of these business

model changes and focused on how both the degree and time between business model changes impacted new ventures' new product introductions and survival rates.

As such, these studies provide important insights in the concept of the business model change processes of new ventures in an emerging industry, and thereby contribute to the fields of business models, organizational change, organizational learning, alliances, effectuation and entrepreneurship. In the remainder of this chapter, I first summarize the most important findings of the studies and draw some conclusions. Next, I will discuss the contributions to the academic literature and the practical implications. Finally, I will conclude this chapter with the limitations and some avenues for future research.

6.2 Main findings and contributions

The goal of this dissertation was to provide an overview of the business model literature, as well as to provide an answer to the general research question: "What are the causes and consequences of new ventures' business model change processes in an emerging industry?" In the next paragraphs, I will list the main findings of the three main studies in this dissertation.

The first study of this dissertation was a review of the business model literature. This literature review was written on the basis of 34 publications in top academic journals that were identified using a topic search for the terms "*business model"* and *"business models"*. The review made clear that there were six main topics on which business model research had focused. The first topic dealt with defining business models and what exactly business models do. A second topic was business models for specific industries and settings, such as biotechnology and e-commerce. A third main stream of research focused on the impact of business models on performance. The fourth and fifth topics that were commonly addressed focused on business model innovation. The fourth

topic investigated how firms and individuals can build innovative business models, that is, business models that are new to the industry (Snihur, 2013), while the fifth research stream focused on the adoption of innovative business models by incumbents, replicators and new entrants. The final research stream focused on business model change processes. The study further identified that there are a number of studies that claim to draw on the concept of business model or that claim to contribute to this literature, but that only focus on related concepts such as value creation and strategic decision making.

From an empirical point of view, the majority of studies adopted a case study approach, while about one third of the studies adopted a quantitative approach and about one fifth used a mathematical model.

Based on the overview of the research topics and empirical methods most commonly used in previous business model studies, I then proposed four priorities for further research in the business model literature. The first gap suggested that more research should focus on the topic of business model change. While some studies had already focused on business model change, most of these studies adopted a case study approach. Moreover, the antecedents of business model change, as well as its performance implications were still underexplored. The second theoretical gap in the literature was that few studies focused on the role of a firm's ecosystem and alliance partners. Despite the fact that firms increasingly are part of ecosystems and need to depend on their partners to create value (Kapoor & Lee, 2013), almost no studies on business models accounted for the role of the firms' alliance or ecosystem partners. As a firm's business model should reflect the way in which it intends to deal with its key partners (Amit & Zott, 2001; Osterwalder & Pigneur, 2010), I suggested that future research on business models should adopt a more holistic perspective and pay attention to the role of a firm's alliance partners and the firm's position within an ecosystem.

I then also suggested that more business model research should focus on new ventures and on emerging industries. Most of the existing studies either did not focus on a specific setting, or focused on the adoption of innovative business models that were created by new entrants in an industry, by established ventures. Building the right business model is especially important for new ventures (Andries, Debackere, & Van Looy, 2013; Blank, 2013) and firms in emerging industries, however (Teece, 2010). As a result, I suggested that more studies should focus on this empirical contingency. I further argued that, given the increasing number of studies on business models, and the growing maturity of the field, more studies should adopt a quantitative approach to validate some of the insights that were generated by earlier qualitative studies or to test existing theories in the field.

Based on these suggested gaps, I then executed the second study of this dissertation. This quantitative study addressed all four gaps: it focused on business model change, adopted an alliance partner perspective, and focused on new ventures in an emerging industry. More specifically, it addressed the research question: "How do business model experimentation and alliance activities of new ventures in emerging industries affect their business model development processes?" While previous studies had argued that business model change could have an important impact on a firm's performance (e.g. Andries et al., 2013), few studies had focused on the antecedents of business model change. Based on organizational learning and effectuation theory, I suggested that firms that changed their business models in the past would be more likely to change it again. As business model experimentation could be seen as a form of trial-and-error learning, firms that had changed their business models in the past would subsequently be more likely to engage in such change behavior again. However, I argued that business model experimentation would also lead to more incremental, i.e. smaller changes, in a firm's business

model. This was caused by the fact that firms typically change their business models based on what they learned from their environment. The more frequently they engaged in change, the more likely it was that their business model was already more adapted to this environment and thus, that the changes they would undertake in a subsequent business model change would be smaller.

Similarly, I argued that firms would also engage in business model change as a result of interorganizational learning. Firms that established more alliance partners would be more likely to change their business model, to a certain extent, after which this likelihood would then decrease again. I also argued that there would be an inverted U-shaped relation between the number of new alliances a firm established and the degree to which a firm changed its business model. Since alliances typically bring in more novel information than what firms would be able to collect or learn on their own, business model change instigated by alliance formation should be more radical. However, as firms cannot completely overhaul their business model without any continuity with their previous business model, I thus argued that the effect of more alliances on degree of business model change would decrease again. Finally, I argued that alliances would moderate the negative effect of business model experimentation on degree of business model change, since firms that engage in trial-and-error learning, due to their experimentation behavior, and interorganizational learning, due to their alliance formation behavior, would be able to learn from a broader source of knowledge than firms that only engage in business model experimentation behavior.

Using a longitudinal sample of new ventures in the mobile health industry, I was able to find that business model experimentation does not lead to business model change, but does lead to a lower degree of business model change. Conversely, alliances have an inverted U-shaped relation with the likelihood of engaging in business model change, but not with the degree of business model

change. Finally, the results provided support for the notion that alliance formation mitigates the negative relation between business model experimentation and degree of business model change.

In the third study, finally, I provided an answer to the research question "How do organizational change processes of new ventures in emerging industries have an impact on their performance?" This study again used a quantitative approach, and addressed the gaps of business model change, new ventures and emerging industries. In this study, I conceptualized organizational change as business model change, and analyzed how these change processes impact the performance of a new venture in an emerging industry. Few studies had focused on the impact of organizational change on performance in new ventures. Moreover, most studies on organizational change focused on either continuous, incremental change or discontinuous, radical change. In this study, I teased the two apart to investigate what the separate impacts of time between business model changes and degree of business model change was. New venture performance was measured as new product introductions and survival rates for remaining an independent venture and for being acquired. I argued that business model change would increase performance, and that a higher degree of business model change and time since last business model change would have a negative impact on performance. Finally, I argued that continuous, incremental change would lead to higher performance than discontinuous, incremental change and that discontinuous, radical change would lead to a higher performance than continuous, radical change.

I used a sample of 173 new ventures in the emerging mobile health industry to test these hypotheses. The results showed that firms that had changed their business models only had a higher number of new products on the market than firms that have never changed their business models, but did not have higher rates of surviving as an independent venture. I also found that degree of business model change only had a negative impact on the number of new products introduced in

the year following the business model change and on the likelihood of surviving as an independent venture, but that the likelihood of being acquired was not affected by the degree of business model change. A longer time since business model change did not have a negative effect on performance, and conversely, lead to a lower likelihood of being acquired. Finally, the results showed that time since last business model change only significantly moderated the effect of degree of business model change in the case of new product development, and not when survival rates were used as a performance indicator.

6.3 Academic contributions

This dissertation makes multiple contributions to academic literature. In the next paragraphs, I will elaborate on the main implications for the business model, organizational change, organizational learning, alliance, effectuation and entrepreneurship literature.

6.3.1 Implications for the business model literature

This dissertation has contributed to gaining deeper insights into the processes, causes and consequences of business model change. While business model change had been argued to be an important process by several researchers (e.g. Andries et al., 2013; Blank, 2013; Sosna, Trevinyo-Rodriguez & Velamuri, 2010), the topic of business model change was nevertheless underresearched, especially in a context of new ventures in an emerging industry. This dissertation has contributed to the knowledge that alliance formation and business model experimentation can be seen as antecedents of engaging in the event of business model change and undertaking more incremental business model change, respectively. Moreover, this dissertation has also shown that, while business model change may not increase the survival rates of new ventures, it does not have a detrimental impact on these two outcomes, and has a positive impact on new product

development. Additionally, the results of the second empirical paper of this dissertation have shown that the performance implications of different organizational change types are largely similar to the performance implications of these types of changes in more established ventures and in more mature industries. As such, this dissertation has created more insights in both the antecedents and performance implications of business model change.

Furthermore, the two empirical studies in this dissertation were among the first large sample, quantitative studies on business model change, and by extension, on business models. The business model literature has sufficiently matured such that it no longer is necessary to exclusively use qualitative studies to build and advance the theory. By using a sample of 193 new ventures in this dissertation, I was also able to make contributions to the business model literature by testing some of the propositions and findings or earlier, smaller sample and qualitative studies.

Finally, by focusing on business model change, and its antecedents and performance implications, this dissertation has also contributed to an increased knowledge of the business model concept. The results of this dissertation have shown that business models should not be construed or thought of as static concepts. From a more empirical perspective, this study has also conceptualized some variables related to business models and business model change, such as degree of change and time in between changes that can be used in further studies.

6.3.2 Implications for the organizational change literature

This dissertation has viewed business model change as an example of organizational change. As a result, the findings of this dissertation can also be seen as contributions to the organizational change literature. First of all, most studies on organizational change had focused on established ventures (Ambos & Birkinshaw, 2010) in established industries. The findings of this dissertation

thus extend the organizational change literature by focusing on new ventures, active in an emerging industry. In the first empirical study, the results have shown that both intraorganizational learning, i.e. business model experimentation, and interorganizational learning can explain the likelihood or degree to which firms undertake organizational change and can thus be seen as drivers of early organizational change processes. These two mechanisms can be seen as alternatives to the mechanism of "fit", or rather, lack of fit, that has been considered the predominant driver of change in established ventures in established industries. Because of the high uncertainty surrounding new ventures in emerging industries, fit is less likely to be present, and a sudden lack of fit can thus not be considered as a driver of organizational change. Experimentation and alliances can thus be seen as mechanisms explaining organizational change in high-uncertainty environments, such as the emerging mobile health industry, where fit is less likely to explain organizational change.

A second contribution to the organizational change literature is the fact that most previous studies in that literature focused on either continuous, incremental change or discontinuous, radical change. By disentangling the degree of business model change and time in between business model changes, I was able to analyze the separate effects of these two variables on performance. The results showed that the degree of change has a negative impact on performance, while the time since last business model change does not seem to have an impact. I also looked at the interaction effect between these two variables, and found that the predominant change mechanisms, i.e. continuous, incremental and discontinuous, radical change have the highest performance with regards to new product development, but do not have a higher performance on the likelihood of ceasing to exist as an independent venture or of getting acquired. This shows that the organizational change literature should not constrain itself by only looking at these two popular types of change, but should further investigate the separate effects of degree and time in between business model

changes. In addition, the results of the second empirical study also showed that the performance implications of business model change processes of new ventures in emerging industries are largely similar to those of more established ventures in mature industries. This study has thus contributed to the organizational change literature by extending its reach and showing that its implications and findings are also applicable in the context of new ventures in an emerging industry.

6.3.3 Implications for the organizational learning literature

In the study on antecedents of business model change, I drew on the concepts of trial-and-error and interorganizational learning. Trial-and-error learning represented the process of business model experimentation, where interorganizational learning was represented by learning from alliance partners and thereby engaging in business model change. The findings of this dissertation have shown that both concepts play a role in the business model change process, be it in explaining the likelihood or the degree of business model change, and as such, that the organizational learning theory has an application in the business model change literature. The finding that inraorganizational learning predicts the degree of business model change, while interorganizational learning predicts the likelihood of business model change, has, to my knowledge, not been found in previous studies, making this another contribution to the organizational learning literature.

6.3.4 Implications for the alliance literature

This dissertation also made some contributions to the alliance literature. The first empirical study of this dissertation has shown that alliances can be seen as drivers of business model change, thereby extending the existing literature that has shown that alliances could be seen as mechanisms

to attract resources (Ahuja, 2000), information (Burt, 1992) and to gain a higher status (Podolny, 1994), as well as drivers of various change mechanisms such as technology change (Lambe & Spekman, 1997). The results of this dissertation have shown that the relation between new alliances and the likelihood of business model change holds an inverted U-shaped relation, and that there is no relation between the degree of business model change and alliances. This study has thus contributed to the alliance literature by showing that alliances can be seen as a predictor of business model change, but do not have an influence on the degree of business model change.

6.3.5 Implications for effectuation literature

By drawing on the concept of effectuation to explain the business model experimentation behavior of new ventures in an emerging industry, this dissertation has also contributed to the effectuation literature. The results did not find empirical support for the fact that business model experimentation increases the likelihood of engaging in additional change behavior, meaning that effectuation theory does not predict whether or not firms will engage in change behavior. The results did find support, however, for the hypothesis that business model experimentation leads to more incremental change, and that, as a firm has more alliances and thus more sources to learn from, the more incremental change as a result of business model experimentation will be alleviated to a certain extent, in the sense that the firm will engage in more radical change behavior when both experimentation and alliances are present. These findings show that effectuation theory explains the degree to which firms engage in change behavior and that both internal and external sources of learning are important in explaining this degree of change. This study has thus contributed to effectuation theory by further investigating its role in explaining change processes of new ventures in emerging industries, and by showing that an effectual logic only plays a role in explaining the degree of change, rather than the likelihood of change. By drawing on effectuation

theory in explaining the link between experimentation and business model change, finally, this dissertation has also responded to a call for more research on the link between business model change and effectuation (Perry, Chandler, & Markova, 2012).

6.3.6 Implications for the entrepreneurship literature

Finally, this dissertation has also contributed to the entrepreneurship literature. One of the most important questions in the entrepreneurship literature has long been: "Why and how do new ventures grow and evolve?" (Gilbert, McDougall, & Audretsch, 2006). By focusing on both the antecedents and performance implications of new ventures' business model changes, this dissertation has responded to this question. By identifying experimentation and alliances as antecedents of business model change, this dissertation has provided an answer to the "why?" component of this question. While there may be other drivers of new ventures' business model change processes, this dissertation has nevertheless provided two mechanisms that can be considered as antecedents of change. Secondly, by looking at the performance implications of new ventures' business model change processes, this dissertation has also responded to the "how do new ventures evolve?" component of the question. Some business model change processes have a negative impact on the performance of new ventures, e.g. more radical business model change leads to a higher likelihood of ceasing to exist as an independent venture, which also ends the growth and evolution processes of this venture. As such, gaining more insights in the the performance implications of new ventures' business model changes has contributed to a deeper understanding in the growth processes of new ventures, and has thus contributed to the entrepreneurship literature.

6.4 Practical implications

The insights generated in this dissertation also offer some practical implications to entrepreneurs, venture capitalists and other financiers, and policy makers.

6.4.1 Implications for entrepreneurs

Overall, this dissertation can provide entrepreneurs with more insights in the organizational change processes of new ventures in an emerging industry. The first empirical study of this dissertation has shown that both business model experimentation and the formation of new alliances have an impact on the likelihood to engage in and the degree to which a firm changes its business model. This information can be relevant for entrepreneurs that want to engage in business model change but do not know how to initiate it. While establishing alliances will not automatically lead to business model change, the resources and information that alliances can provide access to can make it more likely that entrepreneurs will engage in business model change. Moreover, it is interesting to know that alliances alleviate the negative impact of business model experimentation on degree of business model change. Firms that have engaged in business model experimentation behavior may be stuck in only making incremental changes to their business models. This dissertation has shown that by combining business model experimentation processes with alliances, the business model change will be more radical than it would have been had the new venture only engaged in business model experimentation.

The second empirical study of this dissertation has shown that business model change processes, overall, do not have a negative impact on performance. While more radical business model change has a negative impact on a venture's new product development and likelihood to exist as an independent venture in the year following this business model change, these negative effects disappear when looking at their performance implications more long-term. The results also show that business model change has a positive impact on new product development, while not having

any negative performance implications on the two other performance measures. These results can thus be helpful to entrepreneurs who want to initiate in organizational change, but who are afraid of potential negative performance implications.

6.4.2 Implications for venture capitalists and other financiers

When entrepreneurs engage in business model change, and therefore depart from their initial business model, venture capitalists can sometimes see this as a signal that the initial business plan was inadequate, rather than as a signal that the entrepreneurs have learned from their environment and felt the need to change their new venture accordingly (Andries et al., 2013; Clarysse, Wright, & Pauwels, 2015). The results of this dissertation have shown that business model changes, in the long run, do not have any negative performance implications for new ventures and even contribute to having more products on the market, which has been shown to be an important indicator of a firm's market value and survival (Katila & Ahuja, 2002). The findings of this dissertation thus show to venture capitalists and other financiers that potentially want to discourage firms from changing their business models that business model change does not have any negative performance implications and thus should be encouraged by the venture capitalists.

6.4.3 Implications for incubators and accelerators

The finding in this dissertation that business model experimentation and alliances contribute to business model change can be relevant for incubators and accelerators. Incubators and accelerators can set up programs that bring new ventures in contact with potential alliance partners. By bringing access to resources and information, alliance partners can potentially help new ventures to engage in business model change. Incubators and accelerators should thus support new ventures that are willing to undertake change, but do not know how. Moreover, the finding that business model

change does not have any negative long-term consequences can further help incubators and accelerators encourage new ventures that want to change their business models, but are afraid of potential negative consequences.

6.4.4 Implications for policy makers

Finally, this dissertation also has some implications for public policy makers. Public policy programs that aim to help new ventures in their development and growth could benefit from the knowledge that new ventures' business model changes do not have negative long-term consequences. As such, government funding programs for new ventures should not strictly adhere to milestones related to previous versions of business plans and models if firms can provide sound arguments for the need for business model change. Public policy programs should thus include support measures for new ventures that want to change their business models. Financial support could be a part of this, but also bringing new ventures in contact with potential alliance partners can be helpful for new ventures, as this dissertation has shown that the establishment of new alliances increases the likelihood that new ventures will undertake business model change.

6.5 Limitations and avenues for future research

In this dissertation, I have examined the causes and consequences of new ventures' business model changes in an emerging industry. Despite the contributions this dissertation has made, it is not without limitations. In the next paragraphs, I will elaborate on the main methodological limitations of this dissertation, more specifically, limitations on the sample, variables and methods of analysis. I will also offer some avenues for future research that can address these limitations.

6.5.1 Sample

This study uses a unique dataset that was built for the purpose of this dissertation. While it is valuable, there are some inherent limitations associated with it.

Although no efforts were made in the sample selection of this study to limit the sample to the US, only eight of the 193 ventures for which data was collected, were not based in the US. This is due to the fact that the MobiHealthNews and Rock Health reports mainly focus on the US mobile health industry. As a result, the results and implications of this study are mainly applicable to the US mobile health industry, and may not be generalizable to firms outside of the US. Future research could thus use a more globally located sample of mHealth firms or could focus on the mobile health industry in another location, e.g. the European mHealth industry, and see if the results of this dissertation are valid in that setting as well.

Furthermore, the focus of this dissertation was on the emerging mobile health industry. Single industry studies give the researcher a more clear interpretation of the events under study, as potentially confounding industry effects are not possible, which increases the internal validity (Osiyevskyy & Dewald, 2015). However, it is always possible that the findings of this dissertation will not be valid in other industries, and as such, are not generalizable. When conceptualizing the variables used in the two empirical studies, however, efforts were made to use generic variables, meaning that none of the dependent and independent variables were specific to the mHealth industry and cannot be used in other industries. As the mobile health industry is not characterized by features that cannot be found in any other industry, and as all variables and methods used in this dissertation can be used in other settings, it is likely that the generalizability of this study will not be an issue.

Finally, the data collection was limited to the period 2005-2014. While this period captures the mobile health industry while it is emerging, which is a valuable asset of this data, it is possible that

the sampling period is too short to capture some of the hypothesized relations. For example, it is possible that more firms would get acquired or would fail to survive as an independent venture as a longer period of time goes by. Similarly, the nine year observation period may be too short to capture effects from variables such as number of business model changes or time in between business model changes. Having a longer sampling period could thus potentially lead to finding more or stronger support for the hypotheses. As the mobile health industry is still emerging, and consequently is still quite young, however, it was not possible to use a longer sampling period.

6.5.2 Variables

There are some limitations in this dissertation that are related to the variables that were used and their measurements.

All the variables used in this dissertation were based on secondary data sources. As a result, the quality of the variables is dependent on both the quantity and quality of the secondary information that was available. Although 21 companies were dropped from the initial sample due to a lack of information to reliably code the necessary variables, the data used in this dissertation is nevertheless still dependent on the secondary data sources that were used.

Moreover, as all variables were coded based on secondary data sources, I sometimes had to resort to indirect measures of a variable. Actual performance measures such as revenues, or number of users, for example were not available. As a result, I used new product introductions and survival as performance indicators. The use of a survey would have allowed me to get more direct measures of performance, such as customer adoption rates or even a subjective measurement scale of performance. Due to relying on secondary data, some variables, such as being acquired or not, can capture different types of acquisitions, such as firms that were acquired because they were

successful and firms that were acquired because they were unsuccessful. This can potentially confound some of the results. Having access to primary data sources or conducting interviews with the acquired companies could address this issue. Moreover, data on successful or unsuccessful business model changes could have addressed some of the limitations of the two empirical studies of this firm, such as, if the business model change behavior of firms whose past business model changes were successful is the same as the behavior of firms whose past changes were unsuccessful. By being restricted to secondary data, it is not possible to address these issues.

Additionally, as all variables were coded based on secondary information, the coding of the variables was subject to the coder's opinions. While the business model variables were double coded, and had acceptable inter-rater agreements, the data collected for this dissertation could potentially be different if it was coded by another researcher.

Furthermore, in the two empirical studies of this dissertation, I investigated the impact of experimentation and alliance formation on business model change, as well as the effect of business model change on performance. In both studies, the event or likelihood of business model change, as well as the degree of business model change were used as dependent or independent variables. However, I did not dig deeper into which kind of business model change the companies undertook, e.g. a change of market or a change of technology. Future work could benefit from digging deeper into the specific kinds of business model changes and into what exactly the antecedents and performance implications of these kinds of changes are. Moreover, I did not investigate whether some business model configurations are more susceptible to change than others. As such, future research could benefit from investigating whether and why some business models are more likely to change than others.

6.5.3 Method of analysis

There are also some limitations related to the methods of analysis used in the three studies of this dissertation.

In Chapter 2, in which I conducted a review of the business model literature, I only included papers from 12 top academic journals on strategy, management and entrepreneurship. While this method has been used in other literature reviews (e.g. Wang & Rajagopalan, 2014), there are plenty of other journals that have also published studies on business models. *Long Range Planning*, for example, has published two special issues on business model research, and studies on business models have also been published in more practitioner-oriented journals such as *Harvard Business Review*. While including all the published works on business models would lead to a very high number of studies that would need to be incorporated in the literature review, it is possible that other gaps and directions for future research on business models would have been identified had all these studies been included in the review. Future work could thus investigate to what extent the studies on business models that are published in the top academic journals match the topics of business model studies published in more practitioner-oriented journals.

Furthermore, in most of the analyses of the two empirical studies (Chapter 4 and 5), the effects of the independent variables on the dependent variables were lagged, such that the independent and control variables' values were included for year *t-1* and the dependent variables' values for year *t*. While this solves the potential problem of reversed causality, the results can nevertheless not prove causality. While the hypotheses in both studies have built a sound reasoning as to why certain antecedents could lead to business model change (Chapter 4) and to why and how business model change processes could affect performance (Chapter 5), I cannot rule out the fact that the results were found by chance and were not the result of a causal relation between the independent and the

dependent variables. Future research could use primary data collection or could complement these findings that were based on secondary data with interviews that could prove the causality of these findings.

6.6 Conclusion

In conclusion, this dissertation aimed at providing new insights into the phenomenon of business model change by looking at the antecedents and performance implications in a setting of new ventures in an emerging industry. The studies mainly drew on the business model, organizational change, organizational learning and alliances literatures. I attempted to provide bases for further investigation of this topic and hope that the results of this dissertation will prompt further research in the area.

6.7 References

Ahuja, G. 2000. Collaboration networks, structural holes, and innovation: A longitudinal study. ***Administrative Science Quarterly***, 45(3): 425-455.

Ambos, T. C. & Birkinshaw, J. 2010. How do new ventures evolve? An inductive study of archetype changes in science-based ventures. ***Organization science***, 21(6): 1125-1140.

Amit, R. & Zott, C. 2001. Value creation in e-business. ***Strategic management journal***, 22(6-7): 493-520.

Andries, P., Debackere, K., & Van Looy, B. 2013. Simultaneous Experimentation as a Learning Strategy: Business Model Development Under Uncertainty. ***Strategic Entrepreneurship Journal***, 7(4): 288-310.

Blank, S. 2013. Why the lean start-up changes everything. ***Harvard Business Review***, 91(5): 63-72.

Burt, R. S. 1992. ***Structural Holes***. Cambridge, MA: Harvard University Press.

Clarysse, B., Wright, M., & Pauwels, C. 2015. Business Model Pivoting in New Ventures: a Resource Management Perspective. ***Working paper***.

Gilbert, B. A., McDougall, P. P., & Audretsch, D. B. 2006. New venture growth: A review and extension. ***Journal of Management***, 32(6): 926-950.

Kapoor, R. & Lee, J. M. 2013. Coordinating and competing in ecosystems: How organizational forms shape new technology investments. ***Strategic management journal***, 34(3): 274-296.

Katila, R. & Ahuja, G. 2002. Something old, something new: A longitudinal study of search behavior and new product introduction. ***Academy of management journal***, 45(6): 1183-1194.

Lambe, C. J. & Spekman, R. E. 1997. Alliances, external technology acquisition, and discontinuous technological change. ***Journal of product innovation management***, 14(2): 102-116.

Osiyevskyy, O. & Dewald, J. 2015. Explorative versus Exploitative Business Model Change: The Cognitive Antecedents of Firm-Level Responses to Disruptive Innovation. ***Strategic Entrepreneurship Journal***.

Osterwalder, A. & Pigneur, Y. 2010. ***Business Model Generation: A Handbook For Visionaries, Game Changers, And Challengers***: Wiley.

Perry, J. T., Chandler, G. N., & Markova, G. 2012. Entrepreneurial effectuation: a review and suggestions for future research. ***Entrepreneurship Theory and Practice***, 36(4): 837-861.

Podolny, J. M. 1994. Market Uncertainty and the Social Character of Economic Exchange. ***Administrative Science Quarterly***, 39(3): 458-483.

Sarasvathy, S. D. 2001. Causation and effectuation: Toward a theoretical shift from economic inevitability to entrepreneurial contingency. ***Academy of Management Review***, 26(2): 243-263.

Snihur, Y. 2013. Business Model Innovation: Exploring the Concept, its Antecedents and Consequences: Universidad de Navarra, IESE.

Sosna, M., Trevinyo-Rodríguez, R. N., & Velamuri, S. R. 2010. Business model innovation through trial-and-error learning: The Naturhouse case. ***Long range planning***, 43(2): 383-407.

Teece, D. J. 2010. Business models, business strategy and innovation. ***Long range planning***, 43(2): 172-194.

Wang, Y. & Rajagopalan, N. 2014. Alliance Capabilities: Review and Research Agenda. ***Journal of Management***, http://jom.sagepub.com/content/early/2014/11/04/0149206314557157.

APPENDICES

APPENDIX A – BUSINESS MODEL CATEGORIZATION SCHEME

(Adopted from Andries, Debackere, and Van Looy, 2013)

Offering

How does the company create value? (select one from each set)

- Product / service
- Standardized / some customization / high customization
- Internal manufacturing or service delivery / outsourcing / licensing / reselling / value-added reselling
- Direct distribution / indirect distribution

Market

Who does the company create value for? (select one from each set)

- Type of customer (b-to-b / b-to-c)
- Local / regional / international
- Position of customer in the value chain: upstream supplier / downstream supplier / government / institutional / wholesaler / retailer / service provider / final consumer
- Broad market / niche market
- Transactional / relational

Internal capabilities

What is the company's source of competence? (select one or more)

- Production / operating systems
- Selling / marketing
- Information management / mining/ packaging
- Technology / R&D / creative or innovative capability / intellectual
- Financial transactions / arbitrage
- Supply chain management
- Networking / resource leveraging

Competitive strategy

How does the company competitively position itself? (select one or more)

- Image of operational excellence / consistency / speed
- Product or service quality / selection / features / availability

- Innovation leadership
- Low cost / efficiency
- Intimate customer relationship / experience

Economic factors

How does the company make money? (select one from each set)

- Pricing and revenue sources: fixed / flexible
- Operating leverage: high / medium / low
- Volumes: high / medium / low
- Margins: high / medium / low

Personal/investor factors

What are the company's ambitions? (select one)

- Subsistence model / income model / growth model / speculative model

APPENDIX B – AVERAGE DEVIATION INDEX AS MEASURE OF INTER-RATER AGREEMENT

In this appendix, I explain how the inter-rater agreement for the relevant variables in this dissertation was calculated based on the average deviation (AD) index.

The average deviation (AD) index was introduced by Burke, Finkelstein, and Dusig (1999) as a measure of inter-rater agreement for judges' ratings of a single target on a single occasion, meaning that it can be applied to a firm-year observation that is only rated once per judge. The AD index differs from other inter-rater agreement indices by taking into account the actual response options that the measurement scale or method has (Burke & Dunlap, 2002).

The AD index is calculated as follows: $AD_{M(j)} = \frac{\sum_{k=1}^{N}|x_{jk}-\bar{x}_j|}{N}$, with N being the number of judges, which is two in this dissertation, and *j* the item or case being judged. x_{jk} is the *k*th judge's rating on item *j*, and $\bar{x}_j$ is the mean of the judges' scores on item *j*. The AD index measures the disagreement between the judges on the rating of a certain item. As a result, lower values equal a higher inter-rater agreement. Burke and Dunlap (2002) suggest that the threshold of acceptable AD indices is determined by the number of potential ratings or answer categories *c*, divided by six. In the case of dichotomous ratings, this threshold value should equal 0.33.

There are four variables in this dissertation for which inter-rater agreement was determined. These variables are whether or not a firm changed its business model, the number of business model items that were changed in a given year, the number of times a firm changed its business model, and the time since the firm's last business model change.

Business model change. This variable was measured as a dummy, i.e. whether or not the firm changed its business model during a given year. As a result, the AD index should be lower than the suggested threshold of 0.33 (Burke & Dunlap, 2002). The average deviation between the two ratings for this variable is 0.23, which thus points to an acceptable agreement between the two raters.

Degree of business model change. This variable was measured as the number of business model items a firm changed during a given year. The business model categorization scheme used in this dissertation consists of 26 items (see also Appendix A). Since firms can potentially change all these business model items at once, or choose not to change anything at all, there are 27 potential response categories. Using the guideline of *c/6*, I find the value of 4.5 as the suggested threshold for the AD index. The value found in this dissertation equals 0.27, which is lower than this threshold and thus can be seen as an acceptable agreement between both raters.

Number of times business model was changed. This variable measures the number of times that a firm has changed its business model. The maximum number of times a firm can have changed its business model equals the firm's age, as the first business model change is considered as a given and change is evaluated on a yearly base. The firms used in this dissertation ranged anywhere from two to nine years old. This means that for firms that were two years old, there were two potential response options (i.e. having changed the business model once or not at all), and for firms that were eight years old, there were eight response options (i.e. ranging from zero to seven). The corresponding AD thresholds are 0.33 (for two response options) and 1.33 (for eight response options). The AD value found for this variable, however, equals 0.30. This value is lower than the lowest suggested AD threshold, and thus points to acceptable inter-rater agreement for this variable.

Time since last business model change. This variable measures the time since last business model change. The maximum possible value for this variable equals the firm's age minus one. The number of response categories, depending on the firm's age, thus ranges from one to eight. The corresponding AD indices for these values are 0.17 and 1.33. The AD index found for this variable equals 0.58. At first sight, the AD index again does not fully meet the threshold for acceptable inter-rater agreement for all cases. The AD index of 0.58 is only acceptable for firms that were at least five years old, and thus had four possible response options ($\lceil 6 * 0.58 = 3.48 \rceil = 4$). When looking at the individual AD indices for all firms that were not five years old, there were only a few cases for which the AD was not acceptable. Moreover, the values for these variables were derived from the business model change dummy variable, for which the inter-rater agreement did meet the AD threshold. As a result, the inter-rater agreement for this variable can likely be seen as acceptable.

REFERENCES

Andries, P., Debackere, K., & Van Looy, B. 2013. Simultaneous Experimentation as a Learning Strategy: Business Model Development Under Uncertainty. ***Strategic Entrepreneurship Journal***, 7(4): 288-310.

Burke, M. J., Finkelstein, L. M., & Dusig, M. S. 1999. On average deviation indices for estimating interrater agreement. ***Organizational Research Methods***, 2(1): 49-68.

Burke, M. J. & Dunlap, W. P. 2002. Estimating interrater agreement with the average deviation index: A user's guide. ***Organizational Research Methods***, 5(2): 159-172.