

Sina Henningsen

Essays on

# Employing Social and Spatial Contagion for Optimizing Marketing Decisions

*Empirical Applications to the*

*Prediction of Innovation Success and the Allocation of Marketing Budgets*

# **Betriebswirtschaftliche Aspekte lose gekoppelter Systeme und Electronic Business**

Herausgegeben von

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In der Schriftenreihe werden Ergebnisse von Forschungsarbeiten veröffentlicht, die sich in herausragender Weise mit Fragen des Managements lose gekoppelter Systeme, virtueller Unternehmen und elektronischer Geschäftsprozesse beschäftigen. Die Reihe richtet sich an Leser in Wissenschaft und Praxis, die Anregungen für die eigene Arbeit und Problemlösungen suchen. Sie ist nicht auf Veröffentlichungen aus den Instituten der Herausgeber beschränkt.

Essays on  
Employing Social and Spatial Contagion  
for Optimizing Marketing Decisions

*Empirical Applications to the  
Prediction of Innovation Success and the Allocation of Marketing Budgets*

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## Preface

The feedback we got was direct, frank, sometimes painful, but always constructive and very helpful. Our mentor has established a demanding but supportive environment in which he has always been approachable for any discussion, quick to respond, and very caring. He has not only appreciated my study- and research-related stays in Sydney, Rome, and Groningen but to a large extent made those and the discussion of our projects at conferences in Atlanta, Nantes, and Ljubljana possible. After getting me from Frankfurt to his Department in Kiel, he brought in his wealth of experience without which I would not have been able to compose this dissertation. For the sum of these reasons, I express my deepest gratitude to my thesis advisor, Prof. Dr. Dr. h.c. Sönke Albers. His way of being, i.e., teaching us to take criticism objectively and to consider it as the (best) way to improvement – for papers and in daily life – has not only influenced the outcome of this work but also me as a person.

My gratitude extends to several other people and institutions. First, I would like to thank Prof. Dr. Joachim Wolf for co-refereeing this work and the speed of delivering his report as well as Prof. Dr. Achim Walter for chairing my oral defense. This doctoral thesis has been written within the post graduate program 'Business Aspects of Loosely Coupled Systems and Electronic Business' at the Christian-Albrechts-University at Kiel and funded by a scholarship granted by the German Research Foundation (Deutsche Forschungsgemeinschaft). To all of them I am much obliged. This is also true for Prof. Dr. Tammo H. A. Bijmolt who gave me the opportunity to spend four months as a visiting scholar at his Department of Marketing at the Rijksuniversiteit of Groningen to work on a joint project. He and the whole department team gave me a warm welcome and made me have a good time in the Netherlands. Finally, I thank my co-authors for the parts they contributed to this work.

I would like to give special thanks to my colleagues at the Department of Innovation, New Media, and Marketing in Kiel for a family-like atmosphere. I will always remember our breaks with chats on the latest Big Bang Theory episode and similar geeky stuff that served as a highly welcome distraction from our unsolved dissertation problems. My gratitude extends to our secretaries Mrs. Hahn-Mieth and Mrs. Hinz – not only for all the warmly provided valuable knowledge only attached to a secretary but also for never being too busy to have a minute for me. The work climate was

rounded off by some student assistants who were very supportive and only sometimes rewarded with chocolate or mum's homemade North Frisian roulades.

Looking back at my PhD time I can say it's been like an unequalled odyssey during which I felt happy when the thesis developed well but felt unhappy when it didn't. I have spent a lot more time with my laptop than with my friends and family all together, having had a bad conscience whenever I didn't take part in private activities because of working towards the PhD but also having felt remorse when I decided the other way round. Thus, my specific gratitude goes to a number of friends who have not gotten tired of teasing me with the question when I will be done with the dissertation (special thanks for that), for discussing the important questions of life, for cheering me up here and there, and for not having stopped to remind me that the world is not only about 'spatial effects' but having taken me out to see or do nice things. Be sure you all contributed to this work in your own special way.

Finally and most importantly, without my family I would not have been able to write this dissertation – or, to be precise, I would not at all stand in life where I stand right now. To my mum and my dad, Gundula und Carsten Henningsen, to my sisters, Saike and Nane, and to my grandmas and grandpas: I am thankful for your unbounded and wholehearted support and trust in all of what I am doing. Even more grateful I am to my parents for giving us kids a home (including some horses) that is a safe place for all of us, and for always being at our side when we need you. Ma und Pa, Ihr seid die besten Eltern der Welt und es ist schön zu wissen, dass wir immer auf Euch zählen können! Ohne Euch hätte ich diese Arbeit nicht schreiben können. Euch widme ich diese Arbeit.

And now? We'll see. "Just walk the earth, meet people... get into adventures," to put it in Jules' words. I'm curious. What is for sure is that the dissertation has been the center of my universe for the longest time of my life – Stine is back!

Sina Henningsen





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# Synopsis

## 1 Introduction

Every year, enormous amounts of money are spent on advertising to positively influence consumers' buying or innovation adoption decisions; in 2010 more than USD 450 billion worldwide (ZenithOptimedia 2011: 3). In order to maximize the returns of such investments, it is of major interest to managers what drives consumer behavior to what extent. A factor that is – next to, e.g., product quality or price (Steenkamp and Gielens 2003) – well-known to be a key determinant of sales response is advertising (Vakratsas and Ambler 1999). In addition to such external drivers of consumer behavior, it has been shown that individual behavior is also subject to internal effects in the form of interpersonal contagion (Godes et al. 2005). These contagion effects cover all kinds of active interaction as well as passive observation including word of mouth, neighborhood or network effects, social norms, and competitive pressures (Van den Bulte and Lilien 2001). Although accounting for such social spillover effects is promising with regard to the optimization of marketing decisions, response models typically assume consumers to act independently since social contagion is hard to observe, to measure, and to operationalize (Skiera and Albers 2008). Since this assumption seems unreasonable for many settings, it has been proposed to approximate social contagion by spatial proximity (e.g., Hägerstrand 1967). This concept is supported by recent studies finding that despite the wide availability of communication means (such as mobile phones or internet) the foremost part of interaction and contagion is still local (Mok, Wellman, and Carrasco 2010). In other words, social contagion is fostered by some form of spatial proximity between consumers which is why geographical distance between actors can be employed as a proxy for social contagion (Garber et al. 2004).

Dealing with methodological as well as empirical aspects, the present work investigates four research questions in the context of optimizing marketing decisions and marketing effectiveness:

- (i) How can social contagion be methodologically integrated into response models?
- (ii) What are the empirical drivers of advertising effectiveness?
- (iii) How can real-life stop/go decisions about the introduction of innovations to the market be improved by accounting for social contagion in success forecasts?
- (iv) How can the allocation of thousands of local marketing budgets be optimized by accounting for spatial spillover effects?

## **2 Research Contributions**

A scholarship granted by the postgraduate program 'Business Aspects of Loosely Coupled Systems and Electronic Business' of the German Research Foundation (Deutsche Forschungsgemeinschaft) allowed to investigate the aforementioned research questions by a doctoral thesis. This research has been conducted under the supervision of Prof. Dr. Dr. h.c. Sönke Albers during my employment as a research associate at his Department of Innovation, New Media, and Marketing at the Christian-Albrechts-University at Kiel. Both their support allowed excellent research conditions which have led to the papers shown in Table 1.

While the first article (A) presents a comprehensive overview of the technique of spatial modeling, the meta-study (B) sums up empirical findings on advertising effectiveness. The empirical studies show how spatial information can be used to improve particular marketing actions such as (C) the introduction of an innovation to the market or (D) decisions about the optimal allocation of a budget across customer segments and regions. In the following, a brief summary of each paper's contribution to its respective research area is given.

Table 1: Overview of Papers

<b>Methodological Article</b>	
A. Spatial Analysis	Sina Henningsen Published in: Albers, Sönke, Daniel Klapper, Udo Konradt, Achim Walter and Joachim Wolf (eds.): <i>Methodik der empirischen Forschung</i> , 3 <sup>rd</sup> ed., Gabler: Wiesbaden, 2009, 413-432
<b>Meta-Study</b>	
B. Determinants of Advertising Effectiveness: The Development of an International Advertising Elasticity Database and a Meta-Analysis	Sina Henningsen, Rebecca Heuke, and Michel Clement Published in: <i>BuR – Business Research</i> , 2011, 4(2), 193-239, VHB Jourqual Category B
<b>Empirical Studies</b>	
C. Predicting Innovation Success – An Extension of the Spatial Divergence Approach	Sina Henningsen, Christian Barrot, and Kristina Petersen To be submitted to: <i>IJRM – International Journal of Research in Marketing</i> , VHB Jourqual Category A
D. Optimal Allocation of Marketing Resources: Employing Spatially Determined Social Multiplier Effects between Physicians	Sina Henningsen, Sönke Albers, and Tammo H. A. Bijmolt Submitted to: <i>IJRM – International Journal of Research in Marketing</i> , VHB Jourqual Category A, invited for resubmission

## 2.1 Methodological Article on Spatial Analysis

"Everything is related to everything else, but near things are more related than distant things." (Tobler 1970). As stated by the first law of geography, people do not act in isolation but are rather influenced by the actions of others. Exemplary studies deal with the effects of neighborhood on food consumption (Case 1991), the effects of

social versus spatial networks on brand preference (Yang and Allenby 2003), or the effect of local behavior on the adoption of innovations (Bell and Song 2007, Machanda, Xie, and Youn 2008). The general finding is that social contagion matters and can be approximated by spatial proximity. Nevertheless, social effects have largely been – and apart from few exceptions even nowadays still are – ignored in marketing modeling. While for the past this fact can mostly be ascribed to a lack of data, today's difficulties have shifted towards a lack of methodological knowledge and available software that is able to handle specific needs, hereby hampering the widespread consideration of social and spatial contagion in marketing models.

The article *Spatial Analysis* is a state-of-the-art article outlining the most relevant issues including (i) the operationalization of neighborhood, i.e., up to which social or spatial distance actors are assumed to exert what degree of influence on one another, (ii) the two main approaches to model spatial effects namely spatial lag and spatial error, (iii) estimation and software, and (iv) statistical testing. In sum, the article intends to encourage the awareness as well as the knowledge about the importance of social contagion and its practical implementation into econometric models among applied researchers. It has therefore been published in the book 'Methodik der Empirischen Forschung' edited by Albers, Klapper, Konradt, Walter, and Wolf in 2009 whose target group are young academics who will most hopefully act as a multiplier for this topic.

## **2.2 Meta-Study of the Empirical Findings on Advertising Effectiveness**

As noted in the introduction, large budgets have been spent on advertising in the last couple of years – and this trend is rising (ZenithOptimedia 2011: 3). Academic findings on advertising effectiveness, often quantified in the advertising elasticity which describes the percentage change in the response variable due to a one percent change in the advertising variable (Albers, Mantrala, and Sridhar 2010), are manifold. Meta-analyses provide generalizations of the wide range of findings such as the identification of major determinants of advertising effectiveness. While gaining a variety of valuable insights, a major shortcoming of prior meta-analyses is that only generalized results are reported whereas the disaggregated raw data are not made available. Under certain circumstances this handling might become problematic since the coding of empirical studies, at least to a certain extent, involves subjective

judgment. In addition, meta-studies would be of greater value if researchers and practitioners had access to the data allowing them to conduct additional analyses of individual interest.

The article *Determinants of Advertising Effectiveness: The Development of an International Advertising Elasticity Database and a Meta-Analysis* addresses these shortcomings by providing a comprehensive international advertising elasticity database (AED) that allows both academics and practitioners to gain detailed insights as well as access to the disaggregated data. Based on this AED, generalizations of empirical findings on advertising elasticity and its determinants are derived. Our results indicate that the average current-period advertising elasticity is 0.09 which value is substantially smaller than the one of 0.12 which has recently been reported by Sethuraman, Tellis, and Briesch (2011). Further, our meta-analysis reveals a wide range of significant determinants of advertising elasticity. For example, we are the first who include hedonic and experience goods as a product category and find that, *ceteris paribus*, elasticities for this type are higher than for other goods. In sum, by making the complete database including all documented coding judgments available to the public, the article is intended to encourage a dialogue as well as further work in the field of advertising research.

### **2.3 Empirical Studies on Optimizing Marketing Decisions**

In real-life management practice, the (non-)introduction of an innovation to the market can result in large monetary gains or losses respectively. A significant share of innovations fails to succeed (in some industries up to 70%, cf. Brockhoff and Chakrabarti 1988) which is why managers have to make stop/go-decisions early after a product launch. So far, most approaches have either focused on aggregate success predictions (e.g., Bass 1969), test market (Fader, Hardie, and Huang 2004), advance purchase orders (Moe and Fader 2002) or purchase intention data (Orbach and Fruchter 2010) which suffer from the need of a long lasting data collection or the fact that intention data might differ from actual behavior. To overcome these limitations Garber et al. (2004) have proposed an innovation success indicator based on cross-entropy using adopters' spatial distribution. The basic idea is that successful products enjoy a higher degree of social contagion which is why the formation of clusters of adopters can be considered as a success indicator. While their approach is well-

founded in theory and supported by simulation results, real-life applications face additional challenges due to potential systematic and random distortions in actual diffusion data.

The third paper of this dissertation, *Predicting Innovation Success – An Extension of the Spatial Divergence Approach*, extends the cross-entropy measure proposed by Garber et al. (2004) by accounting for random spatial clustering (i.e., clusters that have not emerged due to social contagion but are purely random) in order to maintain a meaningful cross-entropy measure and tests the approach in large-scale empirical settings. Employing data on 370,000 adoptions of four digital products, it can be shown that random clustering indeed matters, i.e., wrong stop/go decisions would have been derived for some of the investigated products when not corrected for random clustering. In addition, mathematical constraints to be kept are developed and a recommendation for the optimal combination of temporal and spatial window sizes at which the approach leads to the best forecasting results are given. In sum, the article shows how to overcome the drawback of extant success forecasting approaches by showing how to use spatial data which are available to any firm to improve stop/go market introduction decisions at a very early stage after product launch.

Another central aim of marketing managers that has gained large scientific attention due to its challenging nature is the optimal allocation of budgets (e.g., Fischer et al. 2011). The complexity of determining the optimal amount of marketing spend exists due to (i) the number of budgets to be set, sometimes – in the case of local ones – up to several thousands, and (ii) the existence of spillover effects, i.e., marketing efforts impacting other markets than the ones originally targeted. However, in practice, the allocation problem is often addressed without attention to potential spillover effects (Mantrala 2002, Rao and Miller 1975, Skiera and Albers 2008). Application of such decision rules may lead to significant over- or under-allocation resulting in sub-optimal firm performance (Urban 1975); especially since it has been shown that improving the allocation of budgets has typically higher impact on sales and profits than extending the absolute level of budgets has (Mantrala, Sinha, and Zoltners 1992). Therefore, extant literature lacks an easy-to-understand and -implement decision support tool that accounts for spillover effects while allowing for a subsequent optimization of resource allocation.

Employing hierarchically nested data from the pharmaceutical industry, the article *Optimal Allocation of Marketing Resources: Employing Spatially Determined Social Multiplier Effects between Physicians* presents a two-step procedure that (1) accounts for spatial spillovers in sales response functions and, building on that approach, (2) allows for determining the sales/profits optimizing allocation of budgets across thousands of customer segments and market regions while accounting for spillovers. Employing Bayesian estimation techniques, our results from an empirical application to a prescription drug panel dataset of about 80,000 observations confirm the existence of spillover effects. They indicate that substantial additional sales and profits can be realized via purely reallocating the marketing spend based on a response model that accounts for spillovers. In sum, the proposed two-step procedure allows for the integration of spillovers and a subsequent optimization, is very general, and can be applied in all settings where social, spatial, or other forms of spillover effects are expected.

### 3 Manifestations on Co-Authorships

Three of the four papers have been developed in co-authorship. Except from paper C to which Barrot and Henningsen have contributed equally, the order of authors reflects the contribution to the paper.

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## A. Spatial Analysis

*Sina Henningsen*

Published in:

Albers, Sönke, Daniel Klapper, Udo Konradt, Achim Walter, and Joachim Wolf (eds.): *Methodik der empirischen Forschung*, 3<sup>rd</sup> ed., Gabler: Wiesbaden, 2009, 413-432

### **Abstract**

"Everything is related to everything else, but near things are more related than distant things." (Tobler 1970). As stated by the first law of geography, people do not act in isolation but are rather influenced by the behavior of others. Empirical studies investigating interpersonal decision processes typically find that social contagion, e.g., by the means of word of mouth, matters and can be approximated by spatial proximity. Yet, due to the complexity of such spillover effects, they are often ignored in marketing modeling. This state-of-the-art article therefore outlines the most relevant issues of spatial modeling with regard to (i) the operationalization of neighborhood, i.e., up to which social or spatial distance actors are assumed to exert what degree of influence on one another, (ii) the two main approaches to model spatial effects namely spatial lag and spatial error, (iii) estimation and software, and (iv) statistical testing.

**Keywords:** Word of Mouth, Social Contagion, Spatial Spillovers, Spatial Modeling

## **B. Determinants of Advertising Effectiveness: The Development of an International Advertising Elasticity Database and a Meta-Analysis**

*Sina Henningsen, Rebecca Heuke<sup>1</sup>, and Michel Clement<sup>2</sup>*

Published in:

BuR – Business Research, 2011, 4(2), 193-239,

available at <http://nbn-resolving.de/urn:nbn:de:0009-20-32096>

### **Abstract**

Increasing demand for marketing accountability requires an efficient allocation of marketing expenditures. Managers who know the elasticity of their marketing instruments can allocate their budgets optimally. Meta-analyses offer a basis for deriving benchmark elasticities for advertising. Although they provide a variety of valuable insights, a major shortcoming of prior meta-analyses is that they report only generalized results as the disaggregated raw data are not made available. This problem is highly relevant because coding of empirical studies, at least to a certain extent, involves subjective judgment. For this reason, meta-studies would be more valuable if researchers and practitioners had access to disaggregated data allowing them to conduct further analyses of individual, e.g., product-level-specific, interests. We are the first to address this gap by providing (1) an advertising elasticity database (AED) and (2) empirical generalizations about advertising elasticities and their determinants. Our findings indicate that the average current-period advertising elasticity is 0.09, which is substantially smaller than the value of 0.12 that was recently reported by Sethuraman, Tellis, and Briesch (2011). Furthermore, our meta-analysis reveals a wide range of significant determinants of advertising elasticity. For example, we find that advertising elasticities are higher (i) for hedonic and experience goods than for other goods; (ii) for new than for established goods; (iii) when advertising is measured in gross rating points (GRP) instead of absolute terms; and (iv) when the lagged dependent or lagged advertising variable is omitted.

**Keywords:** Advertising Effectiveness, Advertising Elasticity, Advertising Elasticity Database, Meta-Analysis, Empirical Marketing Generalizations

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## **C. Predicting Innovation Success – An Extension of the Spatial Divergence Approach**

*Sina Henningsen, Christian Barrot<sup>1</sup>, and Kristina Petersen<sup>2</sup>*

Published as:

Working Paper at Social Science Research Network,  
available at <http://ssrn.com/abstract=2124517>

### **Abstract**

The introduction of new products is a major challenge for marketing managers. Since a significant share of innovations fails to succeed, managers have to make stop/go-decisions soon after a product's launch. To support such decisions, Garber et al. (2004) propose an indicator based on cross-entropy using adopters' spatial distribution. While their approach is well-founded in theory and supported by simulation results, real-life applications face additional challenges due to potential systematic and random distortions in actual diffusion data. In our study, we extend the cross-entropy measure by accounting for random spatial clusters, and test the approach in large-scale empirical settings.

**Keywords:** Spatial Distribution, Diffusion, Cross-Entropy, Forecasting

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## **D. Optimal Allocation of Marketing Resources: Employing Spatially Determined Social Multiplier Effects between Physicians**

*Sina Henningsen, Sönke Albers<sup>1</sup>, and Tammo H. A. Bijmolt<sup>2</sup>*

For publication submitted to:

IJRM – International Journal of Research and Marketing, invited for resubmission.

Published as Working Paper at Social Science Research Network,

available at <http://ssrn.com/abstract=2124465>

### **Abstract**

A central aim of marketing managers is the optimal allocation of budgets across customer segments and market regions. Often, these allocation decisions are subject to interpersonal contagion. However, sales response models traditionally assume customers' independence. We present a method for incorporating spatial spillovers into sales response functions and a subsequent optimization procedure that allows for determining sales/profits optimizing budgets across customer segments and regions while accounting for spillover effects. Employing hierarchical Bayesian estimation, our results from an empirical application to a pharmaceutical panel dataset indicate that substantive additional sales/profits can be expected due to incorporating spillovers and thereby improving allocation.

**Keywords:** Resource Allocation and Optimization, Social Contagion, Spatial Models, Spatial Spillovers, Pharmaceutical Industry

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# Curriculum Vitae

## Personal Information

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Sina Henningsen  
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## Education

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06/2006 – 10/2011	PhD under Supervision and Resarch Associate of Prof. Dr. Dr. h.c. Sönke Albers: Scholarship from German Research Foundation (DFG) for a Dissertation at the Department of Innovation, New Media, and Marketing, Christian-Albrechts-University	Kiel
01/2009 – 04/2009	Visiting Scholar of Prof. Dr. Tammo Bijmolt: Joint Work on an Optimization Project at the Department of Marketing, Rijksuniversiteit Groningen	Groningen
05/2008 – 06/2008	Spatial Econometrics Advanced Institute: Spatial Data Analysis Course at 'La Sapienza' University	Rome
04/2002 – 02/2006	Business Administration Studies at Christian-Albrechts-University: Scholarship from Nord-Ostsee Sparkasse Specializations in Innovation, New Media and Marketing, Entrepreneurship and Innovation Management, Controlling	Kiel
07/2004 – 12/2004	Study Abroad Semester at Macquarie University: Lectures on Econometrics, Management, Organization	Sydney
08/1990 – 07/1999	Abitur at Hermann-Tast-Gymnasium: Majors in Mathematics, French, Russian, Geography	Husum

## Professional Experience

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09/2009 – 08/2011	Project Work at German Academic Association for Business Research (VHB)	Kiel Göttingen
03/2006 – 04/2009	Internship at Simon-Kucher & Partners: Project at a big Insurance Company	Frankfurt Bonn
08/2004 – 11/2004	Internship at Aussie PC Shop	Sydney
04/2002 – 02/2006	Various Deployments at Nord-Ostsee Sparkasse during Semester Breaks at the Departments of Wealth, Credit, Human Resources, and Project Management	Flensburg Schleswig Westerland
03/2003 – 06/2003 10/2003 – 12/2003	Student Assistent to Prof. Dr. Helmut Herwartz at the Institute for Statistics and Econometrics	Kiel
08/1999 – 01/2002	Shortened Bank Appenticeship at Sparkasse Nordfriesland	Husum

