On Consumer Purchasing Behavior in Electronic Markets

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"*The Internet is becoming the town square for the global village of tomorrow."*
–Bill Gates

Introduction and Overview

Over the past several decades the Internet has led to the digitalization of many markets. Today, Electronic markets have taken center stage in the modern economy and become common place for consumers in a wide range of transactions. For example, people buy products on Amazon, hunt for bargains in auctions on eBay, or search for product information on Google. One key phenomenon has been the tremendous growth of online sales in the last decade: while in 2002 e-commerce accounted for approximately €8bn of revenue (Frankfurter Allgemeine 2002), it had reached €33bn or 7.7% of the total retail sales volume by 2012, with further expansion to be expected over the coming years (IFH Köln 2013). This shift towards electronic markets opened up countless new opportunities for the scientific study of consumer behavior on an individual level. While in the past the collection of detailed consumer and transaction data in offline markets used to be fraught with challenges, these data have become more readily available in today's electronic markets, with the consequence that consumer behavior can now be analyzed in unprecedented detail. For instance, researchers can observe the occurrence of decision biases in real market transactions (Heyman et al. 2004), bidding behavior in online auctions (e.g., Roth and Ockenfels 2002), purchasing behavior on e-commerce websites (e.g., Brynjolfsson et al. 2011), or product search behavior on search engines (Agarwal et al. 2011).

Understanding consumer behavior is of vital importance to researchers as well as companies across almost all types of industries. For example, Jennifer S. Nelson, global director/global strategy and insights, from Johnson & Johnson states that *"The heart of marketing is behavior modification, and this will remain our focus"* (Precourt 2010). Clearly, the prerequisite for such modifications is a sound understanding of consumer behavior. Since the 1920s, researchers from different disciplines contributed to this understanding (Kroeber-Riel et al. 2009) and by the mid-twentieth century, the analysis of consumer behavior had emerged as a distinct field of research (Robertson and Kassarjian 1991). Robertson and Kassarjian (1991) define the analysis of consumer behavior as *"the scientific study of consumer actions in the marketplace".* One important subarea of this field is the analysis of different types of individual purchase decisions. One criterion for the classification of purchase decisions has been whether they are made with either a high or a low degree of cognitive control (Kroeber-Riel et al. 2009). A more fine-grained classification further distinguishes between (1) impulse purchases i.e., those made by shoppers without advance planning (Stern 1962), (2) routine purchases i.e., mundane and mostly low-risk

purchases based on quick decisions (Kroeber-Riel et al. 2009), (3) purchases involving limited decision making i.e., planned and deliberate purchases based on product experience and/or product knowledge (Kroeber-Riel et al. 2009), and (4) purchases involving extensive decision making, i.e. those which require consumers to extensively solve a problem (Howard 1977). The first two types of purchase decisions are associated with lower, and the latter two are with a higher degree of cognitive control (Weinberg 1994).

The main goal of this dissertation is to utilize the newly available opportunities arising from the emergence of electronic markets to contribute to the understanding of two specific types of purchase decisions: impulse purchases and purchases with extensive decision making. The first, co-authored, paper, *Herrmann, P., D. Kundisch, and M. S. Rahman (2014)*, is an investigation into the sunk cost effect for behavioral investments as a specific trigger for impulse purchases as well as the impact of delegating decision making to IT on the occurrence of this bias. We find that a sunk cost effect for behavioral investments triggers impulsive purchase decisions and, by mitigating behavioral investments, the delegation of decision making to IT is found to reduce the likelihood of the occurrence of this bias, and hence, the likelihood of impulse purchases.

Each of the following three studies (*Herrmann, P. (2014), Herrmann, P., D. Kundisch, and M. S. Rahman (2013)*, and *Herrmann, P., and M. Möller (2013)*) analyzes different aspects of purchasing behavior associated with extensive decision making. In the first paper (*Herrmann, P. (2014)*), I propose an analytical model to examine how consumers use the information contained in the variance of consumer ratings to make better informed purchase decisions. In this model, I consider products where the variance of consumer ratings can be caused by both product failure and consumer taste. The results suggest, that the effects of the variance of consumer ratings on consumer demand and product prices heavily depend on its composition i.e., the relative shares of variance caused by product failure and consumer taste. The second paper on purchase decisions with extensive decision making (*Herrmann, P., D. Kundisch, and M. S. Rahman (2013)*) deals with consumer bidding behavior in a specific type of online auction. Consumers who want to obtain a product via this online auction can adopt different bidding strategies. We investigate the impact of these bidding strategies on a participant's probability of winning an auction and find that an aggressive bidding strategy substantially reduces a participant's likelihood of winning an auction. In the third paper on purchase decisions with extensive decision making (*Herrmann, P., and M. Möller (2013)*), we analyze the product search behavior of consumers on search engines, with a particular focus on the use of sponsored search results in a consumer's selection of a retailer. We study the conversion of impressions of a sponsored search result into clicks as well as the conversion of clicks into actual purchases and how this conversion is affected by the ad's position on the search website. We find a significant decrease of the

click-through rate and cost-per-click when ads move to less prominent ad positions. However, the conversion rate is not affected by these moves. Interestingly, as soon as advertisers leave the top positions, we find a strong negative effect of the ad position on the costs per conversion which is caused by the combination of the lower costs-per-click on these position and the independence of ad positions and conversion rates.

Together, the results of these four studies make an original contribution to knowledge by increasing the understanding of different facets of individual consumer purchase decisions. The results are valuable for consumers, marketers, and researchers alike: consumers may use the results presented in this dissertation to reflect on their own decisions and improve their decision making, while marketers could improve their marketing strategies through a better understanding of consumer behavior. Based on the findings presented in the first four studies they may develop strategies to better align their actions towards the customer and thereby influence consumer behavior more successfully. Moreover, the results from *Herrmann, P., D. Kundisch, and M. S. Rahman (2014), Herrmann, P. (2014), Herrmann, P., D. Kundisch, and M. S. Rahman (2013),* and *Herrmann, P., and M. Möller (2013)* provide valuable starting points for future research in the area of individual consumer purchasing behavior in electronic markets.
This dissertation is rounded off with *Kundisch, D., P. Herrmann, M. Whittaker, M. Beutner, G. Fels, J. Magenheim, W. Reinhardt, M. Sievers, A. Zoyke. (2012)* which contributes to the area of e-learning. In this paper we introduce and evaluate a web-based open source solution that enables us to transfer the widely established Peer Instruction approach to large lecture halls. Amongst its many other applications, this solution has already supported the dissemination of the research results presented in this doctoral dissertation to our students.

The following pages contain a short summary of the studies included in this dissertation. After each summary, the theoretical contributions as well as the managerial implications of each paper are presented. At the end of the introduction a summary table provides detailed information for each of the studies included in this dissertation regarding contributions of the respective co-authors to the studies and the scientific dissemination they gave rise to in the form of conference presentations and publications.

Summary of *Herrmann, P., D. Kundisch, and M. S. Rahman (2014)*

The first paper was a research undertaken jointly with Mohammad S. Rahman and Dennis Kundisch. This study investigates the impact of delegating decision making to information technology (IT) on an important human decision bias – the sunk cost effect. Over the past decade, the role of information technology has evolved from a mere decision aid to a decision making artifact. IT in this context is harnessed not only to support decision makers, but also to make decisions on their behalf. Examples of these technologies include options for involving automated agents for bidding in online auctions

(Adomavicius et al. 2009) or for trading in financial markets (Hendershott et al. 2011). Today, these agents are available at a negligible marginal cost and can effectively act on behalf of their owners. In 2009, for instance, an astonishing 73% of all equity trading volume in the United States was executed by electronic agents (Mackenzie 2009). In the wake of this development a significant literature has emerged, analyzing the design of these software agents, their performance in real market situations, and their effect on market outcomes (e.g., Guo et al. 2012, Hinz et al. 2011). Yet despite the widespread usage of these agents, the impact of the delegation of decision making to IT on different facets of decision making, including decision biases, is still not well understood. Considering the economic importance of these decision biases (DellaVigna 2009), it is all the more critical, therefore, to analyze the effects of automated software agents on the occurrence of decision biases in subsequent human decision making.

Studies of decision biases have featured in the literature for decades (e.g., Kahneman and Tversky 1979, Pope and Schweitzer 2011), both in laboratory and field research (an overview can be found in DellaVigna 2009, for example). One important challenge for researchers is to provide mechanism for analyzing and understanding these biases, and how they can be alleviated or even avoided. Useful contributions to this area have been made by researchers in Information Systems. Several laboratory experiments have shown that decision support systems (DSS) are an effective tool for alleviating some of these decision biases (e.g., Bhandari et al. 2008, Lim et al. 2000, Roy and Lerch 1996). None of these studies, however, analyzed the potential impact of automated software agents – which effectively replace the human decision maker – on the occurrence of decision biases in subsequent human decisions. In addition, there is no evidence to date that the laboratory results associated with DSS and decision biases are transferable to real market situations. This is a handicap for both academics and practitioners because many scholars are skeptical of the transferability of lab-results to the field (e.g., List 2003). Consequently, we investigate whether or not IT can indeed alleviate decision bias in real market transactions.

One common decision bias is the so-called 'sunk cost effect'. This has been defined as the *"greater tendency to continue an endeavor once an investment in money, effort, or time has been made"* (Arkes and Blumer 1985). The sunk cost effect typically occurs in decision situations involving a chain of decisions (e.g., software projects, investments, exploration ventures, auctions) (Kanodia et al. 1989). In many of these situations it is now possible to delegate parts of the decision making to IT (e.g., participants in an online auction could delegate their bidding to an automated agent). Consequently, considering these two phenomena together raises the question of the impact of delegation to IT on the sunk cost effect, which both researchers and practitioners would benefit from better understanding. Having the good fortune of access to data from a real market setting we were able to seize this opportunity to investigate this issue both theoretically and empirically. In particular, we focus on the following research question:

does the delegation of decision making to IT affect the occurrence of the sunk cost effect in a subsequent human decision situation?

More specifically, we theoretically establish and empirically validate the impact of IT on the occurrence of the sunk cost effect. We hypothesize, first, the existence of the sunk cost effect in terms of behavioral investments (e.g., emotional attachment, effort, and time), and second, the mitigating effect of delegating investment decisions to IT on behavioral investments and hence, on the likelihood of the sunk cost effect on subsequent human decision makings. In other words, by mitigating the contributions of different antecedents of behavioral investments, the delegation to IT affects the likelihood of the occurrence of the sunk cost effect. While there is anecdotal evidence for the link between delegating decision making to IT and the reduction of behavioral investments (Bapna 2003), we are not aware of any paper which theoretically or empirically investigates this issue, and hence, there appears to be a gap in knowledge concerning the in-depth understanding of the impact of *behavioral* investments on the sunk cost effect. Previous experimental studies have come up with contradictory results: some have found a positive effect of behavioral investments on the sunk cost effect (e.g., Cunha and Caldieraro 2009, 2010, Navarro and Fantino 2009); others were unable to replicate these experimental results (Otto 2010), or did not find evidence for the existence of the sunk cost effect for a behavioral investment, such as time (Soman 2001).

Theoretical Contributions of *Herrmann, P., D. Kundisch, and M. S. Rahman (2014)*

Our study makes several significant contributions to the literature. First, only a few studies so far analyze the effects of IT usage on decision biases and, more importantly, none of these considered the sunk cost effect. To the best of our knowledge, this paper is the first to explore this issue. We theoretically establish and empirically test the hypothesis that, by reducing behavioral sunk costs, IT can alleviate the occurrence of the sunk cost effect and, thus, improve the quality of decisions. Second, the literature on decision biases and IT focuses almost exclusively on DSS which support human decision makers. Considering the increasing number of opportunities where decision makers can delegate their decision making to automated agents, it is worth investigating the impact of these new information technologies on decision biases. Third, the impact of IT on decision biases was hitherto analyzed only in experimental settings. This is the first study to test these findings in a real market setting. Fourth, the experimental evidence on the sunk cost effect in relation to behavioral investments is very limited, and to the best of our knowledge, it lacks evidence from the field. By theoretically establishing and empirically validating the positive effect of the delegation of decision making to IT in terms of decreasing the occurrence of the sunk cost effect, we provide the first field evidence for the existence of the sunk cost effect for behavioral investments.

Practical Implications of *Herrmann, P., D. Kundisch, and M. S. Rahman (2014)*

The results of *Herrmann, P., D. Kundisch, and M. S. Rahman (2014)* are of particular interest to companies hosting online auctions. These firms need to carefully balance the advantage of providing bidding agents as a means of increasing customer satisfaction with the advantage of increased profitability through the sunk cost effect derived from not providing such agents. In the short term, it may increase profitability if bidders in classical online auctions fall prey to the sunk cost effect for behavioral investments and, therefore, place more and higher bids than they would otherwise have placed without such investments. However, in the longer term, these bidders might feel less satisfied with the auction website.

Understanding the impact of delegating parts of decision making to IT on the sunk cost effect also has more general managerial implications. Our study shows that the sunk cost effect is induced not only by monetary investments but also by behavioral investments. These investments can occur in a wide range of situations consisting of, but not limited to, decisions about project investments, project management, policy making, trading on financial markets, as well as auction participations. A manager, for example, might invest considerable time and effort in evaluating potential project alternatives. Based on the theoretical mechanism described in this study, this manager would perceive the investment alternatives more positively compared to situations where she had not invested any behavioral resources in the evaluation process. If this person were to decide about investment alternatives, there may be a structural bias towards alternatives which require the highest evaluation effort. This bias may lead to the substantial misallocations of capital due to the sunk cost effect. Decision makers would therefore benefit from carefully assessing all types of decision situations in terms of their potential for sunken behavioral investments. Where substantial behavioral investments are likely to be involved, managers should realize that these investments may significantly affect the quality of their decision making. In these situations, one important question to ask is whether a decision would be different without behavioral sunk costs, in which case it may also be appropriate to consult a person who has not invested any behavioral resources or even to delegate the decision to such a person. Furthermore, in some decision situations, the involvement of a software agent or of another dispassionate advisor can detach decision makers from the decision process and, thus, protect them from behavioral investments. The resulting detachment from behavior investment could substantially increase the quality of decisions in various situations and, hence, provide decision makers with a competitive advantage. So far, however, the availability of appropriate software agents for decision situations remains limited. One important challenge for practitioners and researchers from the IS discipline would therefore be the development of automated software agents in order to protect decision makers from behavioral investments in a wide range of decision situations.

Summary of *Herrmann, P. (2014)*

The second paper is a single-authored work in which I theoretically analyze the effect of the variance of consumer ratings on product pricing and consumer demand. Amazon.com claims that such consumer reviews are its most popular feature (New York Times 2004) and contributing to its current success in e-commerce. These reviews are most commonly provided in the form of a star rating system and an optional text review. Amongst other things, online reviews offer a form of peer learning among consumers. Thereby, they transform many former experience attributes of a product into search attributes[1] (Hong et al. 2012). For example, while previously it would have been impossible to evaluate the sound quality of a laptop without actually listening to the device, today's online consumer reviews offer a way of learning about certain product attributes. Not surprisingly, then, 64% of respondents in Forrester Research's online survey said they want to see consumer reviews when shopping online (Kee 2008). Accordingly, online consumer reviews have become one of the main sources of information for online shoppers. Not all experience attributes, however, can be turned into observational search attributes. For example, a perusal of the negative textual consumer reviews for a Cordless Kettle[2] shows that the most common complaint concerned the failure of the automatic shut-off, a fault that developed even after a relatively short period of usage. From these reviews, consumers can learn that the failure of the automatic shut-off presents a common problem for this kettle. What they cannot infer from these reviews, however, is the exact likelihood of their individual product developing this fault.

Much of the information contained in the textual consumer reviews is summarized in the star rating ranging from one (lowest recommendation) to five (highest recommendation) on most e-commerce websites. A bar chart shows the distribution of the awarded consumer ratings with the average rating prominently displayed beneath the product name. Consumers can see how much other consumers liked a product on average and whether all consumers liked the product to the same degree or whether their opinions differed widely by considering the first two moments of this distribution: the average and the variance. Not surprisingly, a significant literature has emerged, analyzing the effects of these different aspects of the distribution of consumer reviews on consumer demand. While several studies find that the absolute number and the average of consumer ratings positively affect consumer demand, we know of only few studies which explicitly analyze the effect of the variance of online consumer ratings on demand (e.g., Clemons et al. 2006, Sun 2012) and none of these studies explicitly analyze this effect depending on whether the variance is caused mainly by observational search (i.e., the sound quality in our example) or by experience attributes (i.e., failure of the water kettle).

[1] Hong et al. (2012) provide an excellent review of the literature on search and experience attributes.
[2] http://www.amazon.com/Aroma-AWK-115S-X-Press-2-Liter-Cordless/product-reviews/B000KDVTJI/

The effect of the variance of consumer ratings on product price and demand may depend heavily on whether it is caused mainly by an observational search or by an experience attribute: by considering variance caused by observational search attributes, consumers can build on the experience of other consumers and learn how well a product fits their individual preferences and criteria (Sun 2012). In contrast, while variance caused by experience attributes provides some information about these attributes, consumers ultimately have to rely on their own experiences for a final evaluation. Thus, this paper considers products where two product attributes may jointly cause the variance of consumer ratings: an observational search and an experience attribute, and whether these different sources of variance differently affect product price and consumer demand. In particular, the paper answers the following research question: *how does the variance of consumer ratings affect product price and demand if this variance is caused by observational search and experience attributes?*

To determine the effect of the different sources of variance of product ratings on product price and consumer demand, I construct an analytical model featuring one monopoly retailer, risk averse consumers and a product where consumer disagreement can be caused by both an observational search attribute i.e., an attribute where consumers can learn from the experiences of others, and an experience attribute i.e., one where consumers cannot learn from other consumers' experiences.

The model is analyzed for three types of products: pure observational search products where the variance of consumer ratings is solely caused by the observational search attribute; pure experience products where the variance of consumer ratings is solely caused by the experience attribute; and observational search and experience products where the variance of consumer ratings is caused by the observational search and the experience attribute.

Theoretical Contribution of *Herrmann, P. (2014)*

The analysis yields the following main results: first, a higher variance caused by the observational search attribute always signals that a product is much liked by some consumers but disliked by others. This results in a higher equilibrium price and lower equilibrium demand. Second, a higher variance caused by the experience attribute signals that there is some risk associated with buying the product resulting in a lower equilibrium price and demand. Third, holding the average rating as well as the total variance of ratings constant and increasing the relative share of variance caused by the observational search attribute reveals an increase in both the equilibrium price and the demand for products with low total variance. Via this mechanism, equilibrium price and demand can increase with increasing total variance of product ratings depending on the composition of the variance of consumer ratings. In other words, this paper demonstrates how risk-averse consumers may prefer a more expensive product with a higher variance of

ratings when deciding between two similar products with the same average rating. These results suggest that the effects of the variance of consumer ratings on consumer demand and product prices heavily depend on its composition i.e., the relative shares of variance caused by observational search and by experience attributes. For researchers, this composition may be an important additional variable when empirically analyzing the effects of consumer ratings. Furthermore, the analytical model presented in this paper provides a theoretical foundation for the empirically observed j-shaped distribution (Hu et al. 2007, Hu et al. 2009) of consumer ratings in electronic commerce. This result could serve as the basis for future analyses of these ratings.

Practical Implications of *Herrmann, P. (2014)*

The findings presented in this paper have important managerial implications: first, retailers could consider the composition of the variance to improve their sales forecast and, thereby, increase their profits by adjusting their stocks accordingly. Second, they could implement mechanisms to explicitly communicate information about the composition of the variance to enable more customers to consider this important information in their decision making. By providing this information, retailers could further reduce information asymmetries in electronic commerce. Moreover, they could charge higher prices for those products where a larger relative share of the variance of product ratings is caused by observational search attributes. Today, consumers can only indirectly infer this information by analyzing specific characteristics of the rating distribution, i.e., a peak in 1-star ratings or by reading through the textual consumer reviews for a specific product. As a first step to making this information directly available, retailers may consider providing additional information about the percentage of the most negative consumer ratings caused by product failure. To collect this information a retailer could ask each consumer who is posting a negative consumer rating whether it is based on product failure or on other factors such as personal preferences.

Summary of *Herrmann, P., D. Kundisch, and M. S. Rahman (2013)*

The third paper is a joint study with Mohammad S. Rahman and Dennis Kundisch, in which we investigate the impact of aggressive bidding on the likelihood of winning an online auction. Today, such online auctions have become a mainstream economic phenomenon, with the total value of goods sold on eBay having reached approximately $70 billion in 2011. It is hardly surprising, then, that for over a decade online auctions have featured prominently as a research topic in the IS literature (e.g., Bapna et al. 2001, Bockstedt and Goh 2012) as well as in the economics literature (e.g., Malmendier and Lee 2011). The analysis of different types of bidding strategies in these auctions features prominently in this literature (e.g., Bapna et al. 2004, Bapna et al. 2009, Kauffman and Wood 2005).

Important components of bidding strategies are bidders' decisions about when to reveal information about their own valuation of the auctioned good. Many bidders are inclined not to reveal their intentions for as long as possible, whereas others intentionally reveal information about their own valuation of the product early on in the bidding process. The first type of bidding strategy is customarily referred to as sniping (e.g., Roth and Ockenfels 2002), in which the bidder waits for the last moment of an auction to submit her bid. In contrast, we refer to the second strategy, when bidders intentionally submit a (high) bid early on in the bidding process, as aggressive bidding.

While there is theoretical (Ockenfels and Roth 2006), experimental (Ariely et al. 2005), and field experimental (Ely and Hossain 2009) evidence that sniping is an optimal response to naïve bidding, the theoretical literature on aggressive bidding suggests at least two competing theoretical explanations for this bidding strategy: signaling and impatience. More importantly, these differing theoretical explanations each offer their own predictions about the effects of aggressive bidding. According to the signaling explanation, the deliberate revealing of information early on in the process is used by bidders to signal their valuation, which is presumed to be high, in an attempt to intimidate competitors; this strategy is seen as increasing their chances of winning an auction (e.g., Avery 1998). The impatience explanation, in contrast, suggests that the early revelation of information is attributable to the attempt to speed up an auction (Isaac et al. 2007) and has no effect on a bidder's winning probability. The empirical evidence on this issue is inconclusive. While some empirical studies conclude that the main driver for aggressive bidding is bidder impatience (e.g., Isaac et al. 2005), there is anecdotal as well as limited evidence from one field experiment that this bidding strategy is able to deter at least part of the competition (e.g., Ely and Hossain 2009).

To this date, we do not know of any empirical study which rigorously evaluates the effect of an aggressive bidding strategy in an attempt to intimidate one's opponents in an (online) auction. For example, the understanding of how the aggressive bidding strategy compares with other bidding strategies is still lacking. The gap in the literature may be explained by the difficulty involved in isolating those bidding situations where bidders submit aggressive bids to signal a high valuation in an attempt to intimidate their opponents. Online pay-per-bid auctions (e.g., beezid.com, bidcactus.com) – which constitute a variant of ascending price auctions – allow us to address this important challenge. In this specific auction format we can rule out impatience as a reason for aggressive bidding and, thus, we are the first to provide an empirical answer to the following research question: *what effect does an aggressive bidding strategy in an attempt to intimidate one's opponents have on a bidder's chances of winning an auction?*

Theoretical Contributions of *Herrmann, P., D. Kundisch, and M. S. Rahman (2013)*

By analyzing aggressive bidding in a pay-per-bid auction context, we are the first to empirically evaluate the signaling value of aggressive bidding and to provide an empirical answer to the question of whether revealing information early on in an online auction context does pay off for the bidder. In the light of the competing theoretical explanations for the existence of aggressive bidding, the different predictions linked to these explanations, and the lack of empirical evidence on the signaling value of aggressively placed bids, our research offers valuable new insights of interest to both information systems research and to behavioral economics research.

Practical Implications of *Herrmann, P., D. Kundisch, and M. S. Rahman (2013)*

The results presented in this study have important implications for bidders, particularly in pay-per-bid auctions, and more generally for bidders in ascending price auctions. Our findings suggest that bidders in pay-per-bid auctions perform substantially worse if they use aggressive bidding as a strategy to discourage competitors. Given the vast amount of aggressively placed bids, aggressive bidders could, ceteris paribus, substantially increase their chances of winning an auction by adopting a very different bidding strategy. Transferring this to a typical ascending price auction, our results suggest that, apart from speeding up the auction and thereby incurring fewer costs associated with the bidding process, adopting an aggressive bidding strategy not only brings no added benefit but may even have a potentially negative effect.

Summary of *Herrmann, P., and M. Möller (2013)*

The fourth paper, *Herrmann, P., and M. Möller (2013),* is joint work with Michael Möller and based on his master's dissertation which was carried out under my supervision. In this research, we analyze the product search behavior of consumers on search engines, with a particular focus on the use of sponsored search results in a consumer's selection of a retailer. We study the conversion of impressions of a sponsored search result into clicks as well as the conversion of clicks into actual purchases and how this conversion is affected by the ad's position on the search website. On most search engines, ads are sold via an auction mechanism for specific search keywords. For each keyword, advertisers place bids based on their maximum willingness to pay for a click by a consumer on an ad for a specified keyword. After an auction, the search engine operator ranks the bidders by their willingness to pay, combined with their ads past click performance. Subsequently, the search engine operator makes a decision about the positioning of the ad on the search website based on this ranking. Typically, there are up to three slots for sponsored search results above and up to eight slots on the right hand side of the organic search results, with the top positions invariably the most costly. But do these top positions offer the best value for the advertiser?

While several studies find that click-through rates (number of clicks divided by the number of impressions of a specific keyword) decrease for less prominent ad positions (Brooks, 2004; Ghose and Yang, 2009; Agarwal et al., 2011, Animesh et al., 2011), there is an ongoing discussion as to which ad position leads to the highest conversion of clicks to actual purchases (Brooks, 2004; Chakravarti et al., 2006; Ghose and Yang, 2009; Agarwal et al., 2011). In particular, experimental results of Chakravarti et al. (2006) suggest that prescreening information is irrelevant in subsequent search behavior, which in turn suggests that conversion-rates (conversions divided by clicks on a specific keyword) should be independent of the ad position whereas Ghose and Yang (2009) and Brooks (2004) find a significant negative relationship between less prominent ad positions and conversion-rates. Contrasting with these results, Agarwal et al. (2011) find a positive relationship between less prominent ad positions and conversion-rates. Brooks (2004) reports the same relationship for unpopular keywords with low search volumes.

With this paper we want to add to this literature. In particular, we answer the following research question: *How does the ad position of a sponsored search result affect its click-through-rate, conversion-rate, and cost-per-conversion?* We answer our research question by analyzing a unique and very rich dataset provided by a big German online marketing agency for several customer projects on Google AdWords, as well as by conducting a field experiment where we display a group randomly selected keywords from one of these customers on less prominent ad positions and compare their performance to a control group which is displayed on more prominent positions. Our dataset contains detailed click and transaction data for the ads for 7,048 keywords from 5 different companies over a 5 month period. The field experiment was conducted for 198 keywords over an eight week period. The results of our analyses are as follows: In our empirical study, we find a significant negative correlation between an ad's position, its click-through-rate, and its cost-per-click and no significant negative correlation between an ad's position and its conversion-rate. As ad-positions are negatively correlated with costs-per-click and uncorrelated or even positively correlated with conversion-rates, costs-per-conversion are also negatively correlated with ad-position. In particular, we find a decrease in the costs-per-conversion of approximately 40% if ads are not listed at the top position but, for example, on the less prominent position four. Validating these results, our field experiment shows a significant and substantial negative relationship between ad-position and click-through-rates, cost-per-click, and costs-per-conversion and no significant relationship between ad position and conversion-rates.

Theoretical Contributions of Herrmann, P., and M. Möller (2013)

Our paper contributes to the existing literature for several reasons: First, our study provides additional empirical and field experimental evidence for the negative effect of an ad's position on click-through-

rates and costs-per-click. By introducing a new dataset consisting of more than 500,000 observations for German retailers from five different categories, our work contributes to the internationalization as well as to the generalization of the previous research on the effects of ad-positioning on key performance indicators in search-engine-advertising. Moreover, our field experiment addresses potential endogeneity concerns regarding the relationship between keywords' ad positions, click-through-rates, costs-per-click, and conversion-rates. Second, there is no consensus about the effect of ad positioning on conversion-rates. With our research, we provide empirical and (field-) experimental evidence that conversion-rates are not negatively and most often even unrelated with ad-positions. Third, recent studies have been able to show that advertisers can substantially increase their profits by not bidding for the top positions for their keywords (Skiera and Abou Nabout, 2013). By empirically and experimentally showing that costs-per-conversion decrease with less prominent ad-positions, our paper provides additional evidence for the potential higher profitability of these ad-positions.

Practical Implications of *Herrmann, P., and M. Möller (2013)*

The findings of our paper might have important managerial implications. Currently, advertisers are engaged in intense bidding wars for the top position in sponsored search results (Agarwal et al., 2011). Our findings emphasize that this strategy might be based on an incorrect assumption about the relationship between ad positions and costs-per-conversion. If an advertiser's main target is to generate a maximal number of conversions with a given daily budget and the daily budget is typically depleted at some point in time, or the monetary and non-monetary value of a conversion is lower than the cost-per-conversion on the most prominent ad position, she may generate a substantially higher value by not participating in these bidding wars. While conversion-rates do not decrease with increasing ad-positions, costs-per-click strongly decrease if advertisers do not compete for the top positions. Combining these two effects leads to diminishing costs-per-conversion for less prominent ad positions. In particular, we show that advertisers can reduce their cost-per-conversion by around 40% if they decide not to bid for the top ad position but, for example, target position four. Still, if an advertiser's main target is to generate as many clicks or conversions as possible, bidding for the top position in sponsored search results might be the best strategy. Higher click-through-rates and constant (or only slightly increasing) conversion-rates at the top positions promise the highest total number of clicks and conversions on these positions.

Summary of *Kundisch, D., P. Herrmann, M. Whittaker, M. Beutner, G. Fels, J. Magenheim, W. Reinhardt, M. Sievers, A. Zoyke. (2012)*

The fifth paper, *Kundisch, D., P. Herrmann, M. Whittaker, M. Beutner, G. Fels, J. Magenheim, W. Reinhardt, M. Sievers, A. Zoyke. (2012),* is a collaboration with Dennis Kundisch, Michael Whittaker,

Marc Beutner, Gregor Fels, Johannes Magenheim, Wolfgang Reinhardt, Michael Sievers, and Andrea Zoyke, and originated as part of the PINGO project (www.upb.de/pingo).[3] In this paper, we introduce a web-based open source solution that enables the transfer of the widely established Peer Instruction approach to lectures with in excess of 350 participants. The study was motivated by the widely documented fact that undergraduate and graduate students often lack in-depth understanding of key concepts in all sorts of subject areas, and research has highlighted the limited role played by traditional lecture-style courses in facilitating this understanding (e.g., Beichner et al. 2000, Crouch et al. 2007). On the other hand, the literature has well established that students develop complex reasoning skills most effectively when they actively participate in the subject matter (e.g., Crouch et al. 2001, DeCorte 1996, Hake 1998). Active participation vitalizes and supports the students' learning process much better than the traditional lecture style. One way to foster such participation in the lecture hall is to integrate cooperative activities among students using Classroom Response Systems (CRS). A CRS is any system used in a face-to-face setting to poll students and gather immediate feedback in response to questions posed by instructors. CRS have been tested and used in higher education classrooms since the 1960's (Judson and Sawada 2002), and its benefits documented in different meta-analyses (Fies and Marshall 2006, Roschelle et al. 2004). Over the past decades, technologists have developed and refined electronic CRS that allow students to key in responses using so-called "clickers". The main advantages of electronic CRS over non-technical methods for gathering feedback are, amongst others, the possibility they offer to anonymize the responses (Draper and Brown 2004) and for the instant projection of response graphs for the whole class to see. In addition, Stowell and Nelson (2007) find that classroom participation is higher when electronic CRS are used compared to conventional CRS. Thus, instructors are mostly relying on electronic CRS as instructional tools in the classroom today (e.g., Cleary 2008).

One specific usage for CRS is that it can assist Peer Instruction (PI) (Mazur 1997), a cooperative teaching and learning approach that is well-suited for involving students even in large auditoriums. Technically similar to the ask-the-audience lifeline in "Who Wants to Be a Millionaire?", the students get involved in the lecture by using clickers to answer multiple-choice questions posed by the instructor. The questions are designed to engage students and to instantly reveal potential comprehension difficulties. If the questions are not answered correctly, course participants are encouraged to discuss their answers with their peers or the lecturer may decide to present the same subject matter differently. The benefits of PI have been established in many empirical studies using different methods across different disciplines (see, e.g., Crouch and Mazur 2001, Crouch et al. 2007, Fies and Marshall 2006). However, PI has so far rarely been used in very large groups, i.e., groups of (well) above 350 students. One major reason for the

[3] Within the PINGO project, the author of this thesis contributed to the following further publications: Magenheim et al. 2012, Sievers et al. 2012, Reinhardt et al. 2012, Kundisch et al. 2013a, Kundisch et al. 2013b.

comparably slow dissemination of PI is the high cost of electronic CRS infrastructure, primarily the cost of physical clickers and/or software licensing fees. Moreover, in interviews conducted by the authors, instructors have mentioned the complexity of software solutions and the need for installation as further important technological barriers to the use of PI.

Given the widespread proliferation of smartphones, laptops, netbooks, and other web-enabled end-user devices among students, having recourse to web technology would appear to be a promising way to avoid the cumbersome and costly infrastructure investments normally required for PI. A review of existing PI solutions indicates that the CRS market has recently developed in this direction, but important hurdles remain if a more widespread adoption of PI is to be achieved. In order to help create a technically and didactically favorable environment for the transfer of PI to large audiences, we initiated the PINGO (Peer Instruction for very large Groups) project. The goal of this project is to develop a scalable, web-based, cost-efficient and user-friendly PI application for students and instructors. Hence, we introduce and evaluate a prototype of our web-based solution (referred to as the PINGO system) in this paper. We report results from the evaluation of the PINGO system using the Technology Acceptance Model, the System Usability Scale as well as qualitative interviews.

Theoretical Contribution of *Kundisch, D., P. Herrmann, M. Whittaker, M. Beutner, G. Fels, J. Magenheim, W. Reinhardt, M. Sievers, A. Zoyke. (2012)* and of the PINGO Project

In general, providing the PINGO system to researchers from all around the world provides several opportunities to evaluate the impact of CRS based teaching/learning methods. In particular, the PINGO system enables researchers to evaluate the effectiveness of PI as well as of other CRS-based teaching/learning methods in large groups. Furthermore, researchers can analyze how different configurations of these teaching methods, as well as different designs of the system affect student learning. Finally, PINGO facilitates the evaluation of the effectiveness of different question types integrated in CRS-based teaching/learning methods in large lectures.

Practical Implications of *Kundisch, D., P. Herrmann, M. Whittaker, M. Beutner, G. Fels, J. Magenheim, W. Reinhardt, M. Sievers, A. Zoyke. (2012)* and of the PINGO Project

Having provided the PINGO system for free has created substantial feedback from teachers around the world. Today, more than 1,300 lecturers from around 250 universities are registered users of the PINGO system. These users created approximately 14,000 surveys and collected more than 220,000 votes.[4] Thus, the PINGO system is broadly used to implement CRS-based teaching/learning methods around the world.

[4] Latest usage statistics can be found under pingo.upb.de/stats.

By presenting the PINGO System on numerous occasions, we hope to further facilitate the dissemination of CRS-based teaching/learning methods.

Beating irrationality: Does delegating to IT alleviate the sunk cost effect?

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Abstract

We investigate the impact of delegating decision making to information technology (IT) on an important human decision bias – the sunk cost effect. To address our research question, we use a unique dataset containing actual market transaction data for approximately 7,000 pay-per-bid auctions. In contrast with the laboratory experiments of previous related studies, our research presents the unique advantage of investigating the effects of IT-enabled automated bidding agents on the occurrence of a decision bias in real market transactions. We identify normatively irrational decision scenarios and analyze consumer behavior in these situations. Our findings show that participants with a higher behavioral investment are more likely to violate the assumption of normative economic rationality due to the sunk cost effect. More importantly, we observe that the delegation of auction participation, i.e., actual bidding, to IT significantly reduces the occurrence of the sunk cost effect in subsequent decisions made by the same individual. We can attribute this reduction to the comparably lower behavioral investments incurred by auction participants who delegate their bidding to IT. In particular, by mitigating different contributors of behavioral investments, delegating to IT reduces the likelihood of the occurrence of the sunk cost effect by more than 50%.

Wir untersuchen den Einfluss der Delegierung von Entscheidungen an Informationstechnologie (in unserem Fall automatische Biet-Agenten) auf eine wichtige kognitive Verzerrung im Entscheidungsverhalten: den Sunk-Cost-Effekt. Um diesen Einfluss zu untersuchen, nutzen wir einen Datensatz mit Transaktionsdaten aus ungefähr 7.000 Pay-per-Bid-Auktionen. Im Gegensatz zu früheren experimentellen Studien können wir so den Effekt von automatischen Biet-Agenten auf eine

Entscheidungsverzerrung in einer realen Marktsituation beobachten. Im Rahmen unserer Studie identifizieren wir Entscheidungssituationen, die irrationale Entscheidungsalternativen beinhalten und analysieren das Entscheidungsverhalten in diesen Situationen. Unsere Ergebnisse zeigen, dass Auktionsteilnehmer mit höheren Verhaltensinvestitionen durch den Sunk-Cost-Effekt eine höhere Wahrscheinlichkeit aufweisen die Annahme der normativen ökonomischen Rationalität zu verletzen. Wir beobachten außerdem, dass die Delegierung der tatsächlichen Auktionsteilnahme an einen Biet-Agenten das Auftreten des Sunk Cost Effekts in nachfolgenden Entscheidungen des gleichen Individuums verringert. Diesen Effekt können wir den geringeren Verhaltensinvestitionen von Individuen, die die Auktionsteilnahme an einen Biet-Agenten delegieren, zuschreiben. In Zahlen verringert diese Delegierung durch die Abschwächung unterschiedlicher Quellen von Verhaltensinvestitionen die Wahrscheinlichkeit des Auftretens des Sunk-Cost-Effekts um über 50%.

The impact of the variance of online consumer ratings on pricing and demand – An analytical model

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Abstract

It is well known that consumer ratings play a major role in the purchase decisions of online shoppers. To examine the effect of the variance of these ratings on future product pricing and sales we propose an analytical model which considers products where the variance of consumer ratings results from two types of product attributes: observational search attributes and experience attributes. We find that if a higher variance is caused by an observational search attribute it results in a higher equilibrium price and lower equilibrium demand, whereas if it is caused by an experience attribute the result is a lower equilibrium price and demand. Interestingly, when the average rating as well as the total variance of ratings are held constant and the relative share of variance caused by the observational search attribute is increased, we observe a rise in both the equilibrium price *and* the demand for products with low total variance. Via this mechanism, and depending on the composition of the variance of consumer ratings, it is possible for the equilibrium price and demand to increase with increasing total variance of product ratings. In other words we are able to demonstrate that, when faced with a choice between two similar products with the same average rating, risk-averse consumers may prefer a more expensive product with a higher variance of ratings. Moreover, our analytical model provides a theoretical foundation for the empirically observed j-shaped distribution of consumer ratings in electronic commerce.

Es ist bekannt, dass Kundenbewertungen eine wichtige Rolle im Kaufentscheidungsprozess von Online-Käufern spielen. Um den Effekt der Varianz von diesen Kundenbewertungen auf zukünftige Produktpreise und -Verkäufe zu analysieren, schlagen wir ein analytisches Modell vor, in dem diese Varianz von zwei Arten von Produktcharakteristika verursacht werden kann: Beobachtungs-Such-Attribute und Erfahrungsattribute. Wir zeigen, dass höhere Varianz, die durch ein Beobachtungs-Such-Attribut ausgelöst wird, zu einem höheren Gleichgewichtspreis und zu geringerer

Gleichgewichtsnachfrage führt, wohingegen höhere Varianz, die durch ein Erfahrungsattribut verursacht wird, zu einem niedrigeren Preis und niedrigerer Nachfrage führt. Interessanterweise zeigt sich, dass wenn man die Gesamtvarianz der Kundenbewertungen und den Bewertungsdurchschnitt konstant hält und der relative Anteil der Varianz, die durch ein Beobachtungs-Such-Attribut verursacht ansteigt, dies zu einem Anstieg des Gleichgewichtspreises und der Gleichgewichtsnachfrage für Produkte mit geringer Gesamtvarianz führt. Durch diesen Mechanismus und abhängig von der Gesamtkomposition der Varianz kann es sein, dass die Gleichgewichtsnachfrage und der Gleichgewichtspreis mit steigender Varianz ansteigen. Es ist also möglich, dass risikoaverse Konsumenten ein Produkt mit höherer Varianz und höherem Preis bevorzugen, wenn sie zwischen zwei ansonsten gleichen Produkten entscheiden müssen. Weiterhin liefert unser analytisches Modell eine theoretische Fundierung der empirisch sehr häufig beobachteten J-Form der Verteilung von Kundenbewertungen im Online-Handel.

To Bid or Not to Bid Aggressively? An Empirical Study

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Abstract

We analyze aggressive bidding, used as a strategy to intimidate auction competitors, with regards to its impact on the likelihood of winning an online auction. To answer our research question, we use a dataset containing actual market transaction records for approximately 7,000 online pay-per-bid auctions. Our research design allows us to isolate aggressive bids that are used in an attempt to deter other auction participants by signaling a high valuation. Thus, we can analyze the effects of this strategy on the probability of winning an auction. We find a significant negative effect of aggressive bidding on one's likelihood of winning an auction. Our results suggest that aggressive bidding is not successful in deterring auction competitors. When comparing the effectiveness of different strategies, we find sniping to be up to seven times more effective than aggressive bidding.

In dieser Arbeit untersuchen wir den Effekt einer aggressiven Bietstrategie, mit dem Ziel andere (potentielle) Auktionsteilnehmer von der weiteren Auktionsteilnahme abzuschrecken, auf die Wahrscheinlichkeit eine Auktion zu gewinnen. Um diese Frage zu beantworten, nutzen wir einen Datensatz mit Transaktionsdaten aus ungefähr 7.000 Pay-per-Bid-Auktionen. Der Aufbau unserer Studie ermöglicht es uns aggressive Gebote, die mit dem Ziel andere Auktionsteilnehmer durch die frühzeitige Signalisierung einer hohen Zahlungsbereitschaft abzuschrecken abgegeben wurden, zu isolieren. So können wir den Effekt dieser Gebote auf die Wahrscheinlichkeit eine Auktion zu gewinnen untersuchen. Die Ergebnisse unserer Analysen zeigen einen signifikant negativen Effekt einer aggressiven Bietstrategie auf die Wahrscheinlichkeit eine Auktion zu gewinnen und legen damit nahe, dass eine solche Strategie

nicht erfolgversprechend ist. Verglichen mit einer abwartenden Bietstrategie zeigt sich das eine aggressive Bietstrategie bis zu siebenmal weniger effektiv ist.

Is it Always Best to be on Top?
The Effect of Ad Positioning on Key Performance Indicators in Search Engine Advertising

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Abstract

Search Engine Advertising is one of the fastest growing instruments in online marketing and a major source of costs for online advertisers. In this research, we empirically and experimentally investigate the impact of ad positioning on key performance indicators in search engine advertising namely click-through-rates, cost-per-click, conversion-rates, and cost-per-conversion. We answer our research question by using a unique and very rich dataset provided by an online marketing agency as well as by conducting a field experiment on a major web search engine. Our analysis of the provided dataset shows that click-through-rates and cost-per-click are negatively correlated with the ad position i.e., the topmost ad position has higher click-through-rates and cost-per-click than, for example, positions two and three. In contrast, we do not find a significant negative correlation, and in the majority of cases no correlation, between ad positions and conversion-rates. Thus, due to the high cost-per-click for the top ad positions and the non-existent negative correlation between ad positions and conversion-rates, lower ad positions are also correlated with lower costs-per-conversion compared to the top positions. In particular, we find a decrease in the costs-per-conversion of approximately 40% if ads are not listed at the top position but, for example, on the less prominent position four. Validating these results, our field experiment shows a significant and substantial negative relationship between ad-position and click-through-rates, cost-per-click, and costs-per-conversion and no significant relationship between ad position and conversion-rates.

Bezahlte Suchmaschinenwerbung ist eines der am schnellsten wachsenden Instrumente im Online-Marketing und ein wichtiger Kostentreiber für Online-Werbetreibende. In dieser Arbeit untersuchen wir empirisch und experimentell, wie sich die Positionierung eine bezahlte Suchmaschinenanzeige auf unterschiedliche Key-Performance-Indikatoren in der Suchmaschinenwerbung, namentlich Klickraten,

Konversionsraten und Kosten-pro-Konversion, auswirkt. Wir untersuchen diesen Zusammenhang anhand eines einzigartigen und sehr detaillierten, von einer Online-Werbeagentur bereitgestellten Datensatzes und anhand eines Feldexperiments für bezahlte Suchmaschinenwerbung bei einer großen Suchmaschine. Unsere Analysen des bereitgestellten Datensatzes zeigen, dass Klickraten und Kosten-pro-Klick negativ mit der Anzeigenposition korreliert sind, also die prominenteste Platzierung höhere Klickraten und Kosten-pro-Klick aufweist als zum Beispiel die Positionen zwei und drei. Im Gegensatz dazu finden wir keine negativen Korrelation und in den meisten Fällen gar keine Korrelation zwischen der Anzeigenposition und der Konversionsrate. Die Kombination aus der negativen Korrelation zwischen Anzeigenposition, Klickraten und Kosten-pro-Klick und der nicht vorhandenen negativen Korrelation zwischen Anzeigenposition und Konversionsrate ergibt auch eine negative Korrelation zwischen der Anzeigenposition und den Kosten-pro-Konversion. In Zahlen finden wir ungefähr 40% niedrigere Kosten-pro-Konversion wenn eine Anzeige nicht auf der prominentesten Position sondern auf der weniger prominenten Position vier angezeigt wird. Diese Ergebnisse bestätigend finden wir im Rahmen unseres Feldexperiments einen ökonomisch und statistisch signifikant negativen Zusammenhang zwischen der Anzeigenposition und den Klickraten, Kosten-pro-Klick und Kosten-pro-Konversion und keinen signifikanten Zusammenhang zwischen Anzeigenpositionen und Konversionsraten.

Designing a web-based application to support Peer Instruction for very large Groups

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Abstract

In this research, we introduce a web-based open source solution that enables the transfer of the widely established Peer Instruction approach to lectures with in excess of 350 participants. The proposed solution avoids several existing technical flaws that currently hinder the further adoption of Peer Instruction. We test our solution in a series of lectures with over 500 participants. Within these tests, we evaluate our prototype using the Technology Acceptance Model, the System Usability Scale, as well as qualitative interviews. Both the evaluation results and the feedback from course participants indicate that our new solution is a useful artifact for implementing Peer Instruction in lectures with very large groups.

In dieser Arbeit wird ein Web-basiertes Open-Source-Software-Artefakt vorgestellt, welches die Übertragung des etablierten Peer Instruction-Ansatzes in große Vorlesungen mit mehr als 350 Teilnehmern ermöglicht. Die vorgestellte Lösung vermeidet unterschiedliche existierende technische Schwierigkeiten, die aktuell die weitere Verbreitung des Peer Instruction-Ansatzes verhindern. Wir testen unser Artefakt in einer Serie von Vorlesungen mit über 500 Teilnehmern und evaluieren unser Artefakt im Rahmen dieser Tests mit dem Technology Acceptance Model, der System Usability Scale und qualitativen Interviews. Sowohl die Evaluationsergebnisse als auch das qualitative Feedback von Vorlesungsteilnehmern zeigen, dass unser Software-Artefakt geeignet ist Peer Instruction auch in sehr großen Gruppen zu implementieren.

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