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**Using Experimental Stock Markets to
Identify Innovative Users**

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Abstract

The constant introduction of new products is of great importance for the long-term financial success of companies. Newly launched products in consumer goods and services markets show high failure rates, often reaching 50%. In order to reduce flop rates, companies can integrate innovative and knowledgeable customers, so called 'lead users', into the new product development process. However, the detection of such lead users is difficult, especially in consumer goods markets with very large customer bases. A new and potentially valuable approach for the identification of lead users are virtual stock markets, which have been proposed and applied for political and business forecasting, but not for expert identification yet. The goal of this paper is to analyze theoretically and empirically the feasibility of virtual stock markets for lead user identification. We find in our empirical study that virtual stock markets are an effective instrument to identify lead users in consumer goods markets. Using the proposed method, companies operating in these markets can identify lead users more easily and integrate them into new product development projects. Thus, they can improve the innovation processes and reduce new product flop rates.

1 Introduction

Empirical research has shown the great importance of constantly introducing new products to sustain the financial success of companies (Debruyne et al. 2002; Han, Kim and Srivastava 1998). Thus, companies face the challenge of balancing their product portfolios between older and newly introduced products. However, this task does not only imply maintaining an efficient process for new product development and allocating substantial resources to this process, but most importantly profit maximization requires the successful introduction of a sufficient number of new products in the market. This is an especially severe challenge in consumer products and services markets. Companies operating in these markets face a daunting problem: Newly launched products have shown notoriously high failure

rates over the years, often reaching 50% (Urban and Hauser 1993). One way to reduce flop rates is to better listen to market needs. Research has examined the effects of market orientation on the company's success intensively (e.g., Jaworski and Kohli 1993). One particular form of market orientation is to integrate customers into the new product development process (Gruner and Homburg 2000). However, the crucial problem is to select the right customers for successful integration, because the contributions of customers to new product development vary significantly (Nambisan 2002).

For industrial markets, there exists an entire chain of literature dealing with the question of which type of customer is best to integrate into the new product development process. Von Hippel has proposed the concept of so-called 'lead users' as being the desired type. Most importantly, this class of customers faces future product needs months or even years earlier than normal customers (Urban and von Hippel 1988; von Hippel 1986; von Hippel 1988). Additionally, lead users often try to find solutions to these needs making them a potential source for new product ideas. Thus, by systematically analyzing lead users and tapping their knowledge, companies can detect future needs and trends in the market place and obtain new product ideas to satisfy these needs.

Transferring the lead user concept to the development of consumer products should enhance the success rate of new consumer products. However, when trying to do so, consumer products companies face major obstacles. Customer bases, especially in the field of fast moving consumer products, are often in the 100,000s or even millions. Furthermore, they usually have no direct contact with their customers, which are served in most cases through intermediaries. Thus, traditional methods like survey research may lack the capability of efficiently identifying lead users, given resource and time constraints. Therefore, finding lead users in a traditional way may seem applicable only to a small number of consumer products companies – mainly those operating in smaller markets or those having direct access to a majority of their customers. A central problem is therefore to identify these innovative customers and to integrate them into the new product development process in consumer products markets.

The Internet enables new tools for the integration of customers into the new product development process, because it offers advantages over traditional means of communication in terms of cost, speed and flexibility (Dahan and Hauser 2002; Nambisan 2002). Moreover, the Internet provides consumer products companies a new way to directly communicate with their customers, bypassing intermediaries such as retailers or market research firms. The communication with specific customers can be easily customized in the Internet, which

allows the integration of varying customers into new product development depending on the firm's objectives and the customers' most valuable contribution for a specific new product development task (Dahan and Hauser 2002). One promising field of this virtual customer integration is the identification and integration of lead users, especially in the idea generation and the concept development stage because lead users' input is particularly valuable in the early stage of new product development (Gruner and Homburg 2000; Khurana and Rosenthal 1998; Nambisan 2002). The Internet, because of its inherent characteristics, promises to be an efficient channel to filter out lead users from a large number of anonymous customers.

We suggest using virtual stock markets (VSM) to identify lead users in the Internet. Based on positive results from the area of political forecasting (Forsythe et al. 1992), virtual stock markets have been proposed and applied for business forecasting (Spann and Skiera 2003). Besides forecasting future events like sales or market share, virtual stock markets have been proposed as a tool for concept evaluation in the new product development process (Dahan and Hauser 2002; Chan et al. 2002).

The identification of knowledgeable consumers or experts can be a new area of application for VSM (Spann and Skiera 2003). The idea is to use virtual stock markets as an instrument for lead user identification. A VSM is potentially a suitable instrument for lead user identification because of two effects. First, sophisticated consumers with a higher involvement with the product of interest can be attracted as a participant in a VSM ("self-selection effect"). Second, well performing participants in a virtual stock market display superior market understanding and insight than their (already self-selected) fellow participants ("performance effect"). To the best of our knowledge, no study has addressed or analyzed the feasibility of virtual stock markets for lead user identification yet.

The goal of this paper is to analyze the use of virtual stock markets for the detection of lead users. We will analyze the feasibility of the lead user identification mechanism of virtual stock markets theoretically and empirically in a consumer product setting. If VSMs can be applied as such an instrument, identified lead users can then be interviewed for their needs and, e.g., actively participate in new product concept evaluation and development. This should lead to a reduction of high new product flop rates and hence increase organizational performance in consumer markets.

The remainder of the paper is organized as follows. The next section analyzes the theoretical foundation of lead user identification in consumer products markets via virtual

stock markets. In the virtual stock market section we explain how virtual stock markets work and discuss the different opportunities virtual stock markets provide for market research purposes. The empirical study section contains a description of the empirical study, combining the data from our virtual stock markets with a survey for lead user characteristics. In the final two sections we provide a discussion of the results, the limitations of our research and outline managerial implications in the conclusion.

2 Lead Users in New Product Development

2.1 Lead Users as Innovators

The lead user concept is rooted in extensive research into the origin of ideas for new products and the distribution of activities between manufacturer and customer. This stream of research was pioneered by von Hippel (von Hippel 1976; von Hippel 1978). He had observed that for many industrial products the product idea originated from customer input and that these customers often dominated the new product development process. Von Hippel calls such situations, in which the process is largely dominated by the customer, the "Customer Active Paradigm" (CAP). The opposite situation is the "Manufacturer Active Paradigm" (MAP), where customers only participate in pre-defined market research activities of the manufacturer. His observations led von Hippel to the conclusion that companies should integrate a certain group of customers in order to optimize the results of their new product development processes. He suggested creating user groups and offering special services to those customers that had previously contributed their ideas (von Hippel 1978). Later on, von Hippel extended this idea into the lead user concept.

This group of customers provides more precise information for new product development projects as they already have a need for a potential product. Additionally, they are more willing to participate in a joint project as they significantly benefit from the resulting new product (von Hippel 1986; von Hippel 1988). Thus, the lead user concept can be seen as a synthesis of the Customer Active and the Manufacturer Active Paradigms, as both parties play an active role in a joint development process (Gruner and Homburg 2000). Based on observations from his case studies, von Hippel (1986) concluded that integrating lead users would enhance the success of new products. This assertion has been confirmed by Lilien et al. (2002) who analyze new product performance at 3M company. The authors find that average annual sales of products based on lead user idea generation techniques are on average much higher than for products developed using traditional methods. Moreover, products

based on lead user ideas have a higher degree of novelty and address more original customer needs and thus outperform other new products developed at 3M on both financial and non-financial criteria (Lilien et al. 2002). In an earlier study, Gruner and Homburg (2000) provide additional empirical evidence that the integration of lead users, particularly in the early phases of new product development, has a positive impact on subsequent new product performance.

Recently, several authors proposed tools and methods trying to integrate consumers into the new product development process, pointing at the advantage such integration offers especially for consumer products companies (Sawhney and Prandelli 2001; Thomke and von Hippel 2002; von Hippel and Katz 2002). They argue that consumers should play an active role, as opposed to the passive role in traditional market research, in order to enhance new product performance. Recent studies indicate that lead users indeed do exist in consumer products markets. Innovations for surf- and snowboards were developed by lead users and only later eventually adopted by commercial firms (Franke and Shah 2003; Shah 2002). In other industries, ranging from transportation to outdoor equipment, lead users also produced relevant new product ideas either on their own or in collaboration with other users (Lüthje 2003). All of the above-mentioned authors argue that an important managerial challenge is the identification of customers in consumer markets, which have the required characteristics of a lead user.

2.2 *Identifying Lead Users in Consumer Products Markets*

Von Hippel (1986) has established two basic characteristics of lead users in industrial markets, which can be used to distinguish them from normal customers in a systematic screening process: Lead users face needs that will be general in the marketplace, but they face them months or years before the bulk of that marketplace encounters them and they are positioned to benefit significantly by obtaining a solution to these needs (von Hippel 1986). Lead users are therefore innovative and trendsetting companies that provide insights in future market needs. Lead users often develop own ideas, prototypes or even complete new products related to these new market needs. Because of these inherent characteristics, lead users provide the richest and most valuable information for new product development (Lilien et al. 2002; von Hippel 1986).

We base our definition on the core elements of von Hippel's (1986) lead user concept and adapt it slightly for better and practical use in consumer markets. Lead users in consumer markets must also be innovative and trendsetting. Sawhney and Prandelli (2001) de-

veloped a framework for the selection and integration of proactive consumers, so called 'co-creators', in new product development. They draw an analogy from lead users in industrial markets to their notion of 'trendsetters' as equivalent in consumer markets. In addition to being innovative and novelty seeking, these trendsetters should occupy a central position in a relevant social network (Craig and Ginter 1975; Granovetter 1985; Manning et al 1995). Lead users therefore not only come up with new ideas or make assessments of the company's new product ideas, but they should also adopt new products earlier than the majority of consumers in the marketplace and actively communicate experiences with the new product in their social network. These activities are important for the success of new products (Rogers 1995) and make this type of lead user very valuable for companies in consumer markets.

Lead users in consumer markets should also be dissatisfied with existing product offerings. For consumer products, Lüthje (2003) amends the original lead user criteria established by von Hippel (1986). He proposes to use the construct 'innovation-related benefits' as a criterion, addressing what von Hippel (1986) has called 'unmet needs', and, derived from that, the lead user characteristic 'dissatisfaction' with existing products. Furthermore, Lüthje (2003) suggests to measure the level of user expertise mainly by assessing the degree of knowledge a consumer possesses about a certain product field (Lüthje 2003). Lead users need to be knowledgeable in order to understand the specific product well enough to come up with realistic ideas and to understand the benefits of a new product's innovative features when asked by the company to assess a new product concept. Customer knowledge, which is either known or easy to identify in industrial markets, needs therefore to be explicitly measured in consumer markets. The dissatisfaction with existing products and a high level of product-related knowledge motivate and enable lead users to contribute valuably to the new product development process.

Summing up, a lead user in consumer markets should have the following general characteristics:

- A lead user is an innovative and trend setting consumer in the respective product field.
- A lead user possesses a high degree of product-related knowledge in the respective product field.
- A lead user is dissatisfied with the existing products in the respective product field.

In the following section, we will explore if consumers, who possess the above-mentioned characteristics of a lead user, can be effectively identified via virtual stock markets.

3 Virtual Stock Markets

3.1 Theoretical Foundation of Virtual Stock Markets

The fundamental concept of applying virtual stock markets to the prediction of managerially relevant forecasting problems is to make future market situations expressible and tradable through virtual stocks (Spann and Skiera 2003). Thereby, a VSM is established on which participants can trade virtual stocks related to these future market situations. The cash dividend (payoff) of such shares of virtual stocks depends on the market outcome; that is, the actual outcome of the market situation of interest. Hence, the price of one share of a virtual stock should correspond to the virtual stock market's aggregate expectations of the event outcome and therefore to the discounted expected cash dividend of a share of the stock.

Participants of the virtual stock market use their (individual) assessment of the market outcome to derive an (individual) expectation of the cash dividend of the related share of virtual stock. Accordingly, they compare their expected cash dividend with the virtual stock market's aggregate expectation, which is a function of the stock price. Thereby, they trade their individual assessment. For example, a participant of the virtual stock market anticipates sales of 100 units during the next month for a specific product. The cash dividend of the related share of virtual stock would consequently be \$100 in the case that each unit of sales would correspond to \$1. In the case of a current price of \$95 (\$105); that is, an aggregate expectation of 95 (105) units, this stock would be undervalued (overvalued) according to the estimates of this participant. This individual could try to attain an expected profit of \$5 via buying (selling). If the potential gains in the virtual portfolio value create a sufficiently high incentive for the participants to perform well on the virtual stock market, it is then their best strategy to make transactions according to their individual assessments. In this way, the participants reveal their true assessments of future market situations via their purchases and sales of stocks (Spann and Skiera 2003).

The theoretical foundations for the use of prices in virtual stock markets for forecasting future market developments are the efficient market hypothesis and the Hayek hypothesis (Fama 1970; Fama 1991; Hayek 1945). The efficient market hypothesis is a state descrip-

tion: A market is efficient if all available information is always fully reflected in the prices (Fama 1970). Therefore, if a virtual stock market is efficient, the price of a specific stock reflects all information on the corresponding future market state and, thus, serves as a forecast. The rationale for why the trading mechanism of a virtual stock market should aggregate and display individual assessments in stock prices; that is, be efficient, is based on the so-called Hayek hypothesis. It states that the price mechanism on a competitive market is the most efficient instrument to aggregate the asymmetrically dispersed information of market participants (Hayek 1945; Smith 1982). Since individual assessments are tradable via shares of virtual stocks in a virtual stock market, virtual stock markets create a market for the prediction of a future market situation in which the participants compete on the basis of their individual assessments. Thus, their aggregated information should be reflected in the stock prices. Extensive studies using empirical data as well as laboratory experiments support this informational efficiency of financial markets (see the overviews of Fama 1970, Fama 1991 and Sunder 1995). The good results of political stock markets strengthen this notion (Forsythe et al. 1999).

The ability of virtual stock markets to reflect participants' information in the stock prices depends on several prerequisites (Spann and Skiera 2003). Future market situations need to be tradable via shares of virtual stock. That means that the actual future market situation is unambiguously the basis for the cash dividend of the respective shares of stock; that is, the determination of the cash dividend is clear for participants. Additionally, the participants need to have some knowledge about the future market situation, otherwise stock prices would be set randomly, and markets could not economize on information as stated by the Hayek hypothesis. Furthermore, the incentive created by the payoff mechanism has to be high enough that experts decide to participate and reveal their true valuations.

We identify three main areas for the application of virtual stock markets. The first area is the forecasting of future events that will occur in the short or medium term future. The second area is the evaluation and forecasting of alternatives (e.g., product concepts), which may never occur (i.e. will never be introduced). The third area of application is the use of virtual stock markets in order to detect knowledgeable experts or consumers, which is the identification of lead users analyzed in most of the remainder of the paper.

The forecasting of actual events requires that the true outcome of this event will eventually be known in order to determine the cash dividend of the respective stock. Thus, the cash dividend is determined by the actual outcome and market participants can trade their individual assessments accordingly. Most of the virtual stock market studies to date focused on forecasting future events whose outcome was eventually known (Spann and Skiera 2003).

The same applies to political stock markets, which were first applied to predict the outcome of the Bush vs. Dukakis US presidential election in 1988 (Forsythe et al. 1992). In political stock markets, participants usually trade their assessments of the fraction of votes a particular candidate or party gets in an election (for an overview see Forsythe et al. 1999).

Chan et al. (2002) propose the use of virtual stock markets to evaluate product concepts. In this approach, participants are presented with different design concepts for a new product (e.g., a bicycle pump) and have to trade these different designs in the form of different securities in a virtual stock market (Chan et al. 2002). The outcome of this type of virtual stock market provides the firm with valuable information regarding the optimal design of products and the predicted market success.

3.2 *Lead User Identification via Virtual Stock Markets*

The use of virtual stock markets for the detection of lead users and experts is a third possible area of application, which we propose in this paper. The basic idea of this approach is that a participant's performance in a virtual stock market can be used as an indicator of his or her knowledge and involvement in the issue to be predicted at a virtual stock market. Thereby, this approach can be used in combination, respectively as an extension, to the first approach, i.e., the use of virtual stock markets for the forecasting of future events.

A virtual stock market may be used as a tool to detect such knowledgeable participants because of two reasons. First, consumers who select to participate in a virtual stock market already display a higher involvement with the product whose market success is predicted in this virtual stock market ("self-selection effect"). Usually, self-selection effects have a negative impact on external validity and thus have to be avoided in market research. However, in the context of lead user detection, the aim is to attract as many lead users as possible who are not representative for the entire consumer population. Thus, self-selection in the context of VSM should have a positive effect, as participation in a VSM requires consumers to commit a larger amount of time than in case of participation in other market-research activities. Thus, participants are likely to have a higher involvement with the product. Usually these consumers tend to possess a higher degree of information, making them more sophisticated than the average users (Mittal 1989; Bloch et al. 1989). This also enables them to think of new ideas and to assess the market success of consumer products (Ram and Hyung-Shik 1989).

Second, well performing participants in a virtual stock market display superior market understanding and insight than their (already self-selected) fellow participants ("per-

formance effect"). The linkage between performance and knowledge of participants rests on the theoretical foundation of VSMs, i.e. the efficient market hypothesis and the Hayek hypothesis. If the price on an efficient VSM reflects all information and thus serves as a good predictor of future market situations, then successful participants should be better informed than less successful ones. The superior information of successful participants is due to the fact that successful trading (i.e., increasing one's virtual portfolio value) requires the detection and exploitation of inefficient prices. Inefficient prices in the context of VSMs are incorrect predictions of future market states. Thus, successful participants at a VSM can detect and exploit such incorrect predictions, requiring them to possess superior knowledge about the future market state (e.g., new product success) to be predicted. Therefore, by selecting the top x-percent of participants in a virtual stock market, the initiator of this virtual stock market should end up with a sample of expert participants, respectively lead users. In this case, such identified lead users can then be interviewed for their specific assessments and needs and, e.g., participate in new product concept tests.

Virtual stock markets can have many favorable properties for the detection of lead users. They have a broad reach, being accessible via the Internet. Once set up, any consumer having access to the Internet can register for a VSM and participate in trading. Compared to other methods, VSMs can also be very efficient due to their scalability. Besides expenses for bandwidth, operation costs of VSMs basically stay the same regardless of the number of participants. If a VSM for business forecasting is already in existence, its use for lead user identification is an additional benefit. Thus, it is possible to screen thousands of consumers at the same cost as a few hundred. While this also holds true for web-based survey research, the usage of standard self-explicated survey research is hindered by the fact that the target population, its customer base, is largely unknown to a typical consumer products company. While survey research might be able to deliver more detailed data, its reach is too limited for screening purposes in consumer products markets.

Further, VSMs are centered around a central personal interest of the lead user, appealing to their intrinsic properties. Therefore, they should be more willing to participate in a VSM than in other methods used for screening of consumers for lead user characteristics. In addition, VSMs are an interesting instrument to partake because trading virtual stocks can be more fun than filling out a questionnaire. VSMs therefore promise to overcome an often-observed shortcoming of survey-based approaches to identify lead users. Surveys fail to attract lead users because they do not create enough motivation or provide a targeted incentive for them to participate. Prior studies have shown that lead users are mostly intrinsically mo-

tivated and that the “fun-factor” plays an important role (Franke and Shah 2003; Lüthje 2003). Thus, companies should rely on methods, which match these basic interests of the consumers to be screened. Additionally, the participation in a VSM needs more time than filling out a survey. Thus, participation also serves as a proxy for the willingness of a consumer to participate in an enduring integration into new product development. However, if incentives are provided, an important distinction is that VSM remunerate participants for their successful participation, i.e., their increase of portfolio value through trading. In contrast to that, incentives provided at consumer surveys remunerate consumers for their participation at a survey irrespective of the quality of the answers.

Given the theoretically favorable properties of VSMs, their feasibility as a method for lead user identification will be empirically analyzed in this paper. Based on the discussions in the previous sections, we formulate three hypotheses to test the suitability of VSMs for the detection of innovative users. First, the self-selection effect described earlier should attract over proportionally many lead users among participants when using self-explicated criteria for identification, because participants of a VSM may be more sophisticated and display a higher involvement with the product whose market success is predicted than average consumers. To this extent, the participants of a VSM are analyzed according to display of lead user criteria with the results being compared to other Lead User studies in a consumer products field (Lüthje 2003).

H₁: A VSM attracts more lead users as compared to traditional methods for lead user identification in consumer markets.

Second, we posit that VSMs are an efficient means for lead user identification. Lead users possess superior knowledge about the traded product and have more insights regarding the success potential of products traded in a virtual stock market. This is also due to their much earlier realization of unmet needs as compared to the average consumer. The characteristics making lead users valuable as source for new product ideas and concepts also permit them to analyze the traded products more thoroughly.

Thus, they can detect and exploit inefficient prices, i.e., incorrect predictions, and therefore should on average perform better than the rest of the participants (performance effect):

H₂: Among the top performers of the VSM, there is a disproportionately high number of lead users.

The superior performance of lead users could be achieved by exploiting price inefficiencies in the stock market. Lead Users should be more likely to detect these opportunities to make low risk profit thanks to their superior forecasting ability. Given their high level of involvement and thus also willingness to commit significant time for trading in the VSM, this would result in the following dominant lead user trading strategy: Lead users exploit every perceived marginal price inefficiency, and conduct rather many orders and trades. Thus, the hypothesis to be tested is:

H₃: Lead users conduct significantly more orders and trades than non lead users.

Given the confirmation of the hypotheses, VSMs could be used for the identification of lead users. Therefore, the remainder of this paper analyzes if well performing participants in a virtual stock market really possess an above average proportion of lead user properties, i.e., really fall into this category.

4 Empirical Study

4.1 Study Design

The goal of our empirical study is to analyze the feasibility of VSMs for lead user identification. For this purpose, we test the three hypotheses posited above. Hence, we conducted a VSM and analyzed the results of its participants according to performance as well as conducted a survey concerning their lead user characteristics. For this study, we selected the product category 'movies'. Movies share many common characteristics with other consumer products. As for consumer products, failure rates are high: many movies fail at the box office (Eliashberg and Shugan 1997). Thus, the product development risk is quite high, further severed by the short life cycle of movies (Shugan 1995). The application of marketing research tools is less common in the movie industry than in some fast moving consumer products industries, which heavily rely on market research (Eliashberg et al. 2000; Eliashberg and Shugan 1997). However, both industries largely focus on tools such as concept tests, in which consumers play a more or less passive role (Sawhney and Prandelli 2001). A third common characteristic is that consumers have little scope to come up with products entirely developed on their own. Fourth, movie makers increasingly rely on branding. In recent

years, marketing budgets for movies have grown significantly in order to create strong brands. The increasing trend of sequels is a consequence – just as other consumer products producers, movie makers try to leverage an existing strong brand, because those consumers being satisfied with a movie might be more likely to watch the sequel as well (Sawhney and Eliashberg 1996). Often, this strategy is extended to movie merchandise, which can contribute significantly to a movie's overall revenue. Fifth, box office results have a huge impact not only on merchandise sales but also on subsequent DVD and video rentals and sales of a movie (Lehmann and Weinberg 2000). Both, DVD and videos are consumer products. Therefore, fast moving consumer products are much closer to movies than to the outdoor and sports products described in the existing lead user studies (Lüthje 2003; Shah 2002).

Thus, lead users in the consumer products field and in the movie industry can be assumed to have relevant new product ideas, but it is doubtful that even the most passionate movie amateur comes up with ready-to-use prototypes. However, the example of the amateur screenwriter community Triggerstreet (www.triggerstreet.com) demonstrates that highly devoted users can develop even complex new movie concepts.

The empirical study was divided into two distinct phases. In the first phase, a virtual stock market focusing on the topic of movies was set up. Participants of this VSM called "Movie Exchange" were attracted through a pop-up window and other advertisements on the website of a leading movie theater operator. Participants at this VSM could trade (and predict) the nationwide box-office success (number of visitors). We conducted the VSM in six rounds. Virtual stocks for ten to fifteen movies were traded in each round. In total, virtual stocks were traded for seventy movies. New participants were allowed to register at any point in time, leading to a larger number of participants over time.

Every participant at the movie exchange received in each round an initial endowment of 1,000 shares of movie stock, \$250,000 (virtual) and the provision of an interest free loans of up to \$250,000 (virtual). The portfolio value of previous rounds could not be transferred. Therefore, each participant had the same starting conditions in each round. Stocks were traded at the movie exchange with a double auction market mechanism comparable to the one applied at the New York Stock Exchange. No trade fees were imposed and trading was possible twenty-four hours a day during the time of the virtual stock market.

At the end of the VSM, each share of movie stock received a cash dividend (payoff) according to the total number of visitors of the respective movie until the end of the specific round. The cash dividend consisted of one virtual dollar for every 1,000 visitors:

$$(1) \quad d_{m,T} = 0.001 \cdot Z_{m,T} \quad (m \in M),$$

where:

- $d_{m,T}$: Cash dividend of the m -th movie stock at time T (T = end of round),
 $Z_{m,T}$: Total number of visitors of the m -th movie to model the outcome at time T (T = end of round),
 M : Index set of movies.

The incentives provided at the VSM were an annual ticket for the movie theater operator for the participant with the highest (virtual) portfolio value in each round; the participants with the second and third highest portfolio value received ten free movie tickets and a set of movie merchandise, respectively.

Participants' performance at the VSM for each round is simply measured as the terminal value of participant's portfolio divided by its initial portfolio.

$$(2) \quad r_{i,j} = \frac{V_{T,i,j}}{V_{B,i,j}} \quad (i \in I, j \in J),$$

where:

- $r_{i,j}$: Portfolio return in round i of j^{th} participant,
 $V_{T,i,j}$: Absolute terminal value of portfolio in round i of j^{th} participant,
 $V_{B,i,j}$: Absolute initial value of portfolio in round i of j^{th} participant,
 I : Index set of rounds,
 J : Index set of participants.

To account for the fact that participants could choose to remain inactive without diminishing their chances to win a prize in subsequent rounds, our overall performance measure is defined as the mean performance per active round, i.e. a round in which the participant made at least one trade:

$$(3) \quad r_{M,j} = \frac{1}{n_j} \sum_{i=1}^{n_j} r_{i,j} \quad (j \in J),$$

where:

- $r_{M,j}$: Mean performance per active round of j^{th} participant,
 n_j : Total number of active rounds of j^{th} participant.

In a second step, we asked the participants to answer an online-survey some weeks after the final round of the movie exchange had finished. Participants were invited by email. The questionnaire asked for several lead user criteria and previous experiences of consumers

with being integrated into new product development in the movie industry. In order to increase the response rate, we used a lottery of three gift vouchers with a face value of USD 50 as incentive. The field time of the survey was four weeks. The response rate was 29.2% among participants of the movie exchange, leading to a sample of $n = 102$. Web-surveying technology enabled us to assess the internal validity of results by analyzing the log files of the surveying server. This technology permits to identify user responses that have improbable response behavior such as responding overly fast.

The lead user identification criteria were based on the definition developed in Section 2. Due to the attributes of the product category "movies", we selected the well-established "opinion leadership" construct developed by Childers (1986), which is based on King and Summers (1970), to measure if consumers have innovative and trend setting characteristics. For the other two lead user characteristics, "product-related knowledge" and "dissatisfaction", there were no scales readily available in the literature. We drew on previous research in the lead user field, but also in other, more general fields (Bloch et al. 1989; Oliver 1980). For our purpose, the items had to be altered and extended. Refer to Table 1 for a detailed overview of the items used to measure the three constructs of lead user characteristics.

Table 1: Items Used to Measure Lead User Characteristics

Construct	Measurement item
Opinion Leadership:	<ul style="list-style-type: none">- When you talk to your friends about movies, do you give: very little information – a great deal of information (OL1)- In a discussion of movies, you would most likely: listen to your friends' ideas – convince your friends of your ideas (OL2)- In discussions of movies, which of the following happens most often? Your friends tell you about movies – you tell your friends about movies (OL3)- Overall in all of your discussion with friends and neighbors, are you: not used a source of advice – often used as a source of advice (OL4)
Product-related Knowledge:	<ul style="list-style-type: none">- Movies are very important to me compared to my other hobbies. (PK1)- Movies consume a large portion of my free time in relation to other hobbies. (PK2)- I frequently go to the movies. (PK3)
Dissatisfaction:	<ul style="list-style-type: none">- I am dissatisfied with the movies screened recently at theatres. (DS1)- I would go to the movies more frequently if they would better meet my expectations. (DS2)

Note: All items except for the opinion leadership construct are Likert-type five point scales using "fully agree" and "do not agree" as anchors. The individual anchors for the opinion leadership scale are listed above.

4.2 Results

Initially, we conducted an exploratory factor analysis (see Table 2). The exploratory factor analysis yielded the suggested three dimensions of lead user characteristics. Construct reliability is sufficient for all three factors as indicated by the levels of Cronbach's alpha (Peterson 1994). We checked our model further by conducting an additional confirmatory factor analysis, which supports the earlier results. The statistical quality of the confirmatory factor analysis is satisfactory (GFI = .88, CFI = .89, RMESA = .13).

Table 2: Exploratory Factor Analysis: Dimensions of Lead User Characteristics

Items	Opinion Leadership	Product Knowledge	Dissatisfaction	Community
OL1	.81	.25	.01	.71
OL2	.88	.04	.09	.78
OL3	.71	.39	-.07	.67
OL4	.61	.27	-.35	.56
PK1	.28	.75	-.10	.65
PK2	.27	.85	-.06	.79
PK3	.10	.91	-.04	.83
DS1	.05	-.03	.87	.77
DS2	-.08	-.08	.78	.63
Variance explained	.42	.16	.13	
Cronbach's α	.86	.84	.59	

Note: Principal Component Analysis (Eigenvalues >1), Varimax-Rotation, N=102

Subsequently, we used the three factors to identify lead users in the sample. The threshold level was the sample mean for each factor, being 3.49 for the construct 'opinion leadership', 2.66 for 'product-related knowledge' and 3.48 for 'dissatisfaction'. This step-by-step screening using means as threshold levels has been used in other lead user studies in the consumer products field (Lüthje 2003). This allows us to compare our findings with those of other studies. In our case, this procedure yielded a total of 21 (= 20.6%) respondents fulfilling the required level of the three lead user criteria. This proportion of lead users is much larger than in two of the three consumer product industries (board games and local transport) previously researched (Lüthje 2003). Lüthje (2003) reports a lead user share of less than 10% in his samples surveyed with a self-explicated questionnaire. The third category, outdoor sport equipment, yields slightly less than 30% lead user share. However, we believe that the outdoor sport equipment category and especially the type of product studied, is much closer in its characteristics to industrial markets than to classic consumer markets. Thus, we cannot reject hypothesis 1. However, the lack of comparable studies in consumer products markets prohibits a quantitative analysis. Obviously, virtual stock markets are a suitable tool to attract a large number of lead users on the Internet as we could identify a relatively higher proportion of lead users than with traditional off-line methods.

To examine hypothesis 2, we analyzed top performers in the virtual stock market, i.e. the best 10% and 20% of traders, regarding the fulfillment of the lead user criteria. The cut-

off values for these two groups of traders were a mean performance value for each actively traded round of -0.04 and -0.20 respectively (due to rather high starting values for the stock prices, the whole sample of participants has a negative mean performance of -0.29). An examination of the mean values of the lead user criteria clearly shows that they are increasing with performance with one exception (see Table 3). However, the sample size is too small to make these differences significant even at the 10%-level. However, we believe that this would be the case with a larger sample, as there is a strong theoretical argument for the observed pattern.

Table 3: Lead User Characteristics and Trading Performance

Mean Scores	Bottom 80%	Best 20%	Best 10%
Opinion Leadership	3.43	3.64	3.52
Product Knowledge	2.55	3.03	3.07
Dissatisfaction	3.15	3.40	3.70

Note: Mean values per group are given in the table.

Further, we checked the frequency of lead users and non-lead users depending on trading performance. For this purposes, a comparison is made between the top 20% of traders and the bottom 80% of traders (see table 4). The group of top 20%-Traders has eight lead users out of the 21 lead users contained in the entire sample. Thus, not all lead users outperform non-lead users. However, there is a much larger percentage of lead users among the top performers than in the entire sample. The Fisher-Test shows a significant relationship between trade performance and the frequency of lead users at the .05 level. Thus, our second hypothesis is supported. Top traders in a VSM are more likely to have lead user characteristics than the average trader.

Table 4: Relationship between Top Traders and Lead Users

		Bottom 80% of Traders	Top 20% of Traders	Total
Not a lead user	<i>Frequency</i>	69	12	81
	<i>Proportion</i>	85.19%	14.81%	100%
	Expected Frequency	65.12	15.88	81
	Residual	3.88	-3.88	
Lead user	<i>Frequency</i>	13	8	21
	<i>Proportion</i>	61.90%	38.10%	100%
	Expected Frequency	16.88	4.12	21
	Residual	-3.88	3.88	
Total	<i>Frequency</i>	82	20	102

Note: Fisher-Test for group differences is significant at the .05 level.

Examining the data to test for hypothesis 3 displays large differences for the trading activity between the lead user sub-sample and the remainder of participants. The mean for the lead user-sample is 47.71 trades per active round, for the remainder it is 20.90 trades. The same pattern applies to the number of orders. The mean number of orders for actively traded rounds for the lead user sub-sample is 45.00, whereas it is much smaller (19.35) for the remainder of the sample. These differences are significant at the 1% level (t-test for independent samples). Additionally, we conducted a one-way ANOVA, using mean number of trades per active round and mean number orders per active round as dependent variables and lead user affiliation as independent variable. For both, mean number of trades and orders, the difference is significant at the 1%-level. Thus, hypothesis 3 is supported. Hence, lead users achieve their superior performance via exploiting every perceived marginal price inefficiency by conducting significantly more trades and orders than non-lead users.

5 Discussion

The results of our empirical study show that virtual stock markets are an appropriate instrument to identify lead users in consumer products markets. Thanks to their special characteristics, lead users tend to perform better than average participants in virtual stock markets and achieve this by conducting significantly more trades and orders than non-lead users. Our analyses provided support for the hypotheses that there are over proportionally many lead users among the best performing traders. The proportion of lead users among top 20%-performers is at least as high as the one found in a study using a traditional survey-based research approach to identify lead users in consumer markets (Lüthje 2003). This com-

parison underscores our finding that VSM screening is more efficient than survey-based screening and also yields at least as many lead users in absolute terms.

Hence, performing a virtual stock market could have a double benefit if lead user and expert identification is feasible in addition to forecasting. First, the observed stock prices at a virtual stock market for the success of consumer products can be used for prediction purposes. Second, well performing participants can be identified as lead users, which are then invited to contribute to a company's new product development process.

Another interesting implication can be derived from our result that obviously not all lead users perform well at the VSM. Apparently, not every lead user possesses a superior ability to forecast the market success of new products. A reason for this may be that some lead users cannot translate their assessment of unmet needs to an assessment of a new product's success in the marketplace. VSMs can have the advantage of selecting those lead users who have a better market understanding besides fulfilling the lead user criteria. Especially these lead users are probably the ones most desirable to integrate into the new product development process, because they experience market needs early and can also evaluate the success of new products attempting to meet these needs.

These results are very encouraging for new product development in consumer markets, because lead users can be efficiently identified by means of VSMs on the Internet and subsequently integrated into the new product development process. Lead users provide own ideas for new products, make suggestions for improving existing products and are valuable consultants during the new product development process for refining, assessing and choosing the best product design. The integration of lead users into the new product development process in consumer product markets can be performed via the World Wide Web because of its inherent advantages (Dahan and Hauser 2002; Nambisan 2002). In addition, it is possible to combine off-line with on-line lead user integration. The continuous and systematic integration of lead users in new product development should help to reduce the notoriously high flop rates of new products in consumer markets.

However, our research has some limitations that offer opportunities for further research. First, the mean values of the lead user criteria increase with trading performance in the VSM, however, these increases are not significant due to the small sample size. Hence, subsequent studies with larger samples are required. Second, we have looked into one product category only. Future research should apply VSMs for lead user identification in other

consumer markets. This would permit comparisons across product categories and potentially result in a standardized procedure for lead user detection by means of VSMs.

Third, the limited availability of other studies in the field of lead user identification in consumer products markets prohibits a more quantitative assessment of the comparable advantage over survey-based identification. However, there are strong indications that results in VSMs are indeed superior to those from traditional methods. Fourth, besides attracting rather sophisticated consumers displaying a higher involvement with the product of interest, a VSM might attract consumers with a propensity towards gambling. However, incentives at a VSM – if provided – are linked to performance at the VSM. Therefore, successful participation requires knowledge about the product being predicted and cannot be achieved by gambling alone. Hence, the self-selection effect should still work towards involved consumers even if some of them have an additional propensity towards gambling.

6 Conclusion

Our study demonstrates that VSMs are an effective means to attract and filter large numbers of anonymous customers for lead user identification purposes on the Internet. Lead user identification is therefore made more efficient, as further initiatives such as screening surveys or even workshops can be targeted to the fairly small group of top performers in a VSM, already containing a high proportion of lead users.

This application of VSMs might enhance the possibilities for lead user integration into the development of consumer products as the main obstacle, their identification, can be solved. Thereby, companies might be able to permit innovative consumers to play a greater role in product development without incurring significantly higher costs. Thus, the application of virtual stock markets for lead user identification can be especially valuable in the important early stages of the innovation process that have a decisive impact on new product success.

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