Superstars and Informational Cascades

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Introduction and Overview

Stardom fascinates. Perhaps simply because many of us are charmed by the picture of becoming superstars ourselves. Or maybe it is because of the obscure nature of what one must have or do in order to become a superstar. Evidently, talent is only part of the equipment that one has to bring along in order to reach stardom. Stardom might as well be the result of pure luck. Stardom could also arise due to phenomena of individual behavior that collectively creates superstars. The first two explanations, talent and luck, have the advantage of being able to stand alone without any further theoretical backing. The latter has the advantage of taking the discussion into a direction that is accessible to economic reasoning. And in fact, various economic models have been proposed to unveil the mechanics behind stardom. The following three papers argue that stardom can be explained based on a phenomenon which oftentimes marks the behavior of individuals: Imitation. As Machiavelli once claimed: "Men almost always walk in the paths beaten by others and carry on their affairs by imitating."[1] Machiavelli's observation years ago is still applicable today. The answers to why individuals imitate are manifold. A theoretical framework labeled informational cascades explains imitative behavior based on informational externalities. This model, which goes back to the seminal works of Bikhchandani, Hirshleifer and Welch (1992) and Banerjee (1992), reveals that copying other individuals' behavior can be the rational response to a decision situation that is marked by imperfect information. If cascade theory is applied to stardom phenomena, superstars do not necessarily arise because they have something particularly valuable to offer, but rather because consumers are in fact uncertain with respect to what these stars have to offer. Hence, stardom as outcome of cascade behavior is particularly relevant in markets where consumers are confronted with significant decision uncertainty.

Superstars and Informational Cascades: Stardom as Herding Phenomenon

The first paper of this dissertation establishes the theoretical bridge between the superstar discussion and informational cascades, and stresses the relevance of cascade theory as alternative superstar explanation to the two models which have so far been the theoretical foundation of the debate. One model has been

[1] This quote is out of Niccolo Machiavelli's seminal work *The Prince*.

presented by Rosen (1981) the other model goes back to Adler (1985). Rosen, who defines superstars as individuals who "earn enormous amounts of money and seem to dominate the fields in which they engage" (Rosen (1981), 845), explains superstar phenomena based on differences in talent and new production technologies which permit the joint consumption of particular goods.[2] This applies for example to classical music, when a tenor with superior talent is no longer confined to a concert hall but can serve the entire market by distributing his artistic good in the form of CD's. In contrast to the explanation proposed by Rosen, which requires heterogeneous talent, the theoretical framework established by Adler is able to explain stardom in an economy marked by equally talented consumers. Following Adler, superstars emerge in fields where consumption requires consumption capital. Because consumption capital is acquired by interacting with other knowledgeable individuals, consumers prefer buying from the producer with the largest "consumer network". As a consequence, positive network externalities induce consumers to patronize the same producers, which in turn leads to superstar phenomena.[3] Explaining stardom based on informational cascades has one fundamental advantage, which is that the assumption that consumers have perfect information with regard to the talent of producers or the quality of the goods they offer, a crucial element in Rosen's as well as Adler's approach, is no longer required. Instead, cascade behavior provides a rational explanation as to why individuals, that are not completely certain whether a good is actually of high quality or not, discard their private information and follow the observed decisions of other individuals. A behavior which, when applied to the stardom context, eventually leads to the emergence of superstars. The paper also explains why cascade-based stardom is not necessarily fragile and can be robust to informational shocks by presenting an extended cascade model. Building on earlier research, this model combines the informational externalities of cascade theory with positive payoff externalities. On the one hand, this extension accounts for Adler's point

[2]Many papers studying stardom refer to the talent of a producer while meaning the quality of the good he offers (see e.g. Rosen (1981)). This of course assumes that talent automatically translates into quality or that quality is necessarily linked to talent. While this is only partly true, for the sake of simplicity, this assumption has been applied in this dissertation's line of argumentation as well.

[3]The consumption of a good is subject to network externalities if the utility from consuming that good increases with the number of individuals consuming the same good. A prominent example is the utility an individual derives from using a telephone which increases with the number of individuals also using a telephone.

of how consumers build up consumption capital. On the other hand, it reflects that consumers receive a higher payoff when consuming a good by a producer who is considered trendy. The extended model shows that by accounting for positive payoff externalities, cascades become less sensitive to shocks caused by public information releases or the arrival of a better informed decision maker. However, the extended model also shows that once consumer choice has informational as well as direct payoff effects, herding might emerge either because public information on the quality of a producer outweighs private information or because the producer's popularity forces consumers to ignore their information. The paper also explains why cascade-based stardom phenomena are expected to be particularly relevant in the markets for fine art. Because the value of art is socially determined and thus highly uncertain, decisions of art consumers are expected to be significantly impacted by cascade behavior which eventually creates artistic superstars.

Superstars and Informational Cascades: An Empirical Analysis of Stardom in Markets for Fine Art

The second paper presents empirical evidence that cascade behavior does in fact play a significant role in the formation of superstars. This paper examines markets in which, following the arguments of the preceding paper, stardom triggered by informational cascades is expected to be particularly prominent: the markets for fine art. The empirical findings presented in this paper reveal that cascade behavior among art consumers contributes significantly to the formation of artistic superstars. By empirically analyzing the determinants of artists' auction performance, this paper shows that cascade-based herding significantly influences the choice of art consumers. This influence has a particularly strong effect in market segments where decision uncertainty is considerably high, such as the markets in which contemporary art is traded. The paper also shows that talent has a weaker influence on which artist is able to generate extraordinary auction volume, which indicates that Rosen-style stardom is only of limited relevance in the economic fields that this paper studies. Moreover, the paper presents findings indicating that positive payoff externalities do have an impact on consumer behavior in some segments of the art market. These results substantiate the argument of the first paper: Most markets that are subject to superstar phenomena are characterized by informational as well as payoff externalities. Based on these findings, the paper concludes that informational cascades provide an appropriate explanatory basis for investigating stardom not only in art markets, but in any market where consumers are confronted with a high level of decision uncertainty. However, this paper also notes that, because informational cascades are not the sole cause for herding in art markets, it is difficult to determine to what extent informational cascades truly contribute to the clustering of consumers' decisions.

Superstars and Informational Cascades: Cascade Seeding as Stairway to Stardom

The empirical relevance of informational cascades as "stardom catalyst" leads one to question whether cascades necessarily emerge "naturally" or if cascades might as well be created. The third paper explains how a producer can apply cascade theory as an effective tool to accelerate his superstar career. This paper unveils how the producer can deliberately seed cascade behavior, thereby carrying him to stardom by providing incentives that convince consumers to buy his good. As the paper reveals, whether cascade seeding actually pays off for the "superstar in spe" depends on: the quality of the good he is offering, how well consumers are informed, the size of the market, and whether he faces a competitor who is also trying to manipulate consumer behavior. In an economy with a single influencer, given that this influencer offers a high quality product, the payoff maximizing strategy depends on the number of consumers as well as the quality of their private information. The longer the decision sequence, the higher the equilibrium value with respect to the quality of individuals private information below which seeding a cascade is the optimal strategy. However, if the good is of low quality and would thus not be consumed in a scenario of perfect information, then the producer is better off creating cascade behavior independent of how well informed individuals are or the number of individuals. In an economy of two competing influencers, the findings with respect to the equilibrium strategies are quite striking. As it turns out, as soon as the group of consumers comprises more than two individuals, both influencers try to seed cascade behavior in order to make consumers buy their goods. This equilibrium, which forces producers into an "incentive competition" leaving both of them with an expected payoff of zero, is independent of how much consumers know about the true quality of their goods. And, even more surprisingly, this equilibrium is independent of whether these producers offer goods of homogeneous quality or of heterogeneous quality. Even though this equilibrium is Pareto-inferior to a solution in which both producers agree on not providing incentives, since such an agreement would not be self-reinforcing, both producers would deviate to increase their individual payoff. As the paper points out, cascade seeding does not only apply to superstar phenomena. The creation of informational cascades is relevant in any context where informational cascades might form and provide an influencer with the opportunity to achieve a particular decision outcome by influencing individual decision making behavior. The paper explains how public institutions can influence collective behavior and increase overall welfare by creating or supporting the formation of cascades. Due to the leverage effect of informational cascades, only a small intervention of such an institution is necessary to achieve a significant impact on a group's collective behavior. Cascade seeding would have certainly been to Machiavelli's taste.

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Superstars and Informational Cascades: Stardom as Herding Phenomenon

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Abstract: This paper outlines the relevance of informational cascades as an explanation for stardom in markets in which consumers have imperfect information regarding the quality of goods. Based on a cascade model, which combines informational and payoff externalities, this paper shows that stardom that has been triggered by cascade behavior is less sensitive to informational shocks than predicted by classic cascade theory. The paper also points out that markets for fine art, due to significant uncertainty with respect to the valuation of art, are particularly prone to cascade-based stardom.

Keywords: Superstars, herding, informational cascades, fine art markets

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1 Introduction

Why do a great number of individuals outside the art world recognize works by Picasso while the great majority of art aficionados has never heard of Gurminder Sikand? Why do artists like Damien Hirst or Jeff Coons earn enormous amounts of money while fellow artists barely make a living? The community of art producing individuals is vast. Yet, most artists do not experience much or even any commercial success and create works which remain unnoticed by the public. There are only a few artists who enter a career stage that is marked by worldwide public recognition and high earnings: Superstars.

Rosen defines superstars as a small number of individuals who "earn enormous amounts of money and seem to dominate the fields in which they engage" (Rosen (1981), 845). But how does one become a superstar? Rosen argues that superstar phenomena are due to the imperfect substitutability with regard to the quality of certain goods combined with scale economies in the production of these goods. According to Rosen, people prefer consuming fewer high-quality goods rather than more of the same good at a lower quality level, such as the performance of a particular Mahler symphony. For example, when the consumption of music was limited to live performances this preference simply resulted in a higher willingness to pay for high quality art. With the development of technologies that allowed for the duplication of artistic goods, for example in the form of CD's, the production of music gained access to economies of scale. And since production costs do not increase with the number of individuals consuming this good, few artists with superior talent are able to serve the entire market and consequently small differences in talent generate enormous returns.

According to Adler (1985), superstar phenomena are not necessarily due to differences in talent. The author explains that stars might even emerge in settings where producers of artistic goods are equally gifted. Adler explains star dynamics with network externalities in the consumption of certain goods. Adler argues that, because the appreciation of goods such as art requires consumption capital and because consumption capital is accumulated by interacting with other individuals, some markets are subject to positive network externalities and consumers are therefore better off when focusing on a limited number of producers which results in superstar phenomena.

Both views, which have dominated the stardom discussion to date, hold that consumers have perfect information about the quality of a product or service.[1] Yet, in most markets consumers have only imperfect knowledge about the quality of the goods they consume, and therefore face significant uncertainty when they have to choose between different goods. A theoretical framework, which explains how individuals make decisions in a context marked by limited transparency, has been proposed by Bikhchandani, Hirshleifer and Welch (1992) and at the same time by Banerjee (1992).[2] The authors show how individuals who face imperfect information with regard to the true payoff resulting from their decision engage in behavior of rational imitation which eventually leads to herding phenomena. The authors have labeled this type of herding, which is caused by informational externalities that induce individuals to copy other individuals' behavior, informational cascades.

This paper stresses the relevance of informational cascades as a theoretical basis for the investigation of superstar phenomena. It explains how producers are turned into superstars not because of the superior quality of their goods or because individuals want to share information on these goods with other individuals, but rather because individuals are uncertain as to whether a producer actually offers something of high or of low quality. Hence, superstars emerge because individuals herd after the same producer in order to reduce decision uncertainty. Moreover, this paper presents an extended cascade model which shows why cascade behavior might be less fragile than predicted by theory. Based on this extended model, informational cascades provide a suitable theoretical fundament for explaining superstar phenomena that are stable and not subject to short-term fads. Building on these findings, the paper then examines markets in which stardom caused by cascade behavior is expected to be exceptionally prominent: the markets for fine art. Consumers of fine art face significant decision uncertainty because in these markets the quality of goods is socially determined and not based on objective valuation rules. It is thus expected that cascade behavior contributes significantly to the formation of superstars in these fields.

The remainder of the paper is structured as follows. Section (2) reviews the "classic" stardom debate and presents the two explanatory perspectives which have so far dominated the discourse. This section also provides a brief

[1] Alternative, less prominent superstar models include those proposed by Kremer (1993) and Borghans and Groot (1998).

[2] In the following, the model presented by Bikhchandani, Hirshleifer and Welch (1992) is referred to as "BHW model".

overview of studies that have examined the relevance of these models from an empirical perspective. Section (3) explains how stardom results from informational cascades, and presents an extended cascade model that shows why cascades are not necessarily fragile as predicted by conventional cascade theory and might thus even lead to stable superstar phenomena. The section also discusses the efficiency of stardom that results from cascade behavior. To highlight the relevance of the theoretical findings, section (4) examines stardom in the markets for fine art and the influential role of cascade behavior in these markets. Section (5) concludes and indicates potential directions for the further examination of cascade-based stardom.

2 The Classic Stardom Debate

2.1 Stardom as Reward for the Most Talented

The assessment of superstar phenomena goes back to Rosen's seminal work "The Economics of Superstars" published in 1981. In this paper, Rosen investigates why in certain professional fields, in which for example artists, athletes or actors pursue their activities, market shares as well as rewards are skewed towards the most talented individuals. Rosen argues that skewness of earnings and output in these fields are due to how buyers are "married" to producers - spectators to actors, audiences to musicians or readers to novelists. Hence, according to Rosen, extraordinary rewards for superior talent as well as output concentration are the result of a simple assignment problem.

With regard to the consumption side of this assignment problem, Rosen argues that buyers are often confronted with goods which are characterized by imperfect substitutability of different quality levels. This means that buyers prefer consuming fewer high-quality services in lieu of more services at a lower quality level. Or, as Rosen puts it, people are willing to pay more than a 10 percent premium for a 10 percent increase in quality. For example, individuals prefer listening to one extraordinary performance of Shakespeare's Othello as opposed to a series of unremarkable stagings of the same play. Likewise, a patient is willing to pay a disproportionate higher fee for a more talented surgeon. Rosen claims that imperfect substitutability alone provides an explanation for the convexity of earnings in fields where consumers face services or products of heterogeneous quality.

Rosen argues that superstar phenomena, which are not only characterized by skewed earnings but also by the concentration of output on just a few producers, can only be explained by taking the production side of the assignment problem into account. This point is best illustrated by an example: An individual willing to consume the "Goldberg Variations" shortly after Bach had written this piece of music had no choice but to go to a live performance. This changed when reproduction technologies paved the road for joint consumption and mass audiences. Suddenly, consumers were able to listen to music which had been recorded, and artists no longer faced the restriction of concert halls. They were now able to reach vast audiences with only one performance. And because production costs of music do not increase with the number of listeners consuming it, the most talented performer of this particular Bach concert, the superstar, ends up selling his good to the entire market. Rosen argues that because the goods offered for instance by artists or poets exhibit characteristics similar to public goods, i.e. they allow for joint consumption, combined with the possibility to exclude consumers who are not willing to pay, producers benefit from scale economies. For instance, a photographer has to put the same effort in taking a picture whether only one individual will be looking at it or thousands of individuals. Consequently, the scale economies of joint consumption enable a provider of a good to serve the entire market and, in combination with imperfect substitutability, explain why the most talented representatives of their profession benefit from enormous earnings and command significant shares of their market.

With today's technological advancements in the distribution of cultural goods, for instance music which is bought online or books which are delivered directly to handheld devices, Rosen's simple explanation of superstar phenomena has not lost its appeal.[3] But, as Schulze (2003, 432) points out, Rosen's model makes a number of crucial assumptions which limit its explanatory power. First, the model does not account for product differentiation or heterogeneous tastes and instead requires very narrowly defined markets. Second, the model does not specify why consumer preferences are marked by imperfect substitution. And third, Rosen assumes a given quality hierarchy among producers and does not explain how superstars actually emerge.

[3]Interestingly, due to internet based distribution technologies and peer to peer platforms, music has in fact been partly transformed into a public good and artists are forced to refocus on live performances again.

MacDonald (1988) tackles the latter of these issues and presents an extended version of Rosen's superstar model. The author bases his analysis on a two-period stochastic model in which artists are either of high or of low quality and can decide whether to perform at a certain ticket price or to drop out of the market. The buyer side is represented by spectators who decide which performances to attend given certain ticket prices. Besides ticket prices, the decisions of spectators are also based on reviews on past performances of the respective artist. Hence, spectators are able to accumulate knowledge about the quality of an artistic good. MacDonald's model yields a number of interesting results. Those artists which receive bad reviews in period one quit and leave the market to those with good reviews who then become superstars. Interestingly, only young artists enter the market and are willing to accept low returns in hope for higher earnings in the future.

2.2 Stardom as Network Phenomenon

In contrast to Rosen, whose explanation of superstar phenomena is based on heterogeneous talent, Adler (1985) claims that superior quality is not a prerequisite for exceptional earnings, and that even in a setting with equally talented producers superstars can still emerge. Adler bases his theoretical approach on Stigler and Becker (1977), a seminal work on the economics of taste. Stigler and Becker present a model which shows why individuals engage in demand behavior which the authors label "addictive consumption". The fundamental argument of Stigler and Becker is that individuals gain experience when consuming the same good and that this experience translates into consumption capital. Due to the consumption capital which an individual accumulates when consuming a particular good, he is able to decrease the costs linked to the consumption of this specific good. Consequently, a consumer that has consumed a particular good is more inclined towards consuming the same good in the future because of increasing marginal utility in consumption. Adler applies this concept of addictive consumption to the context of cultural goods. He argues that the consumption of art requires consumption capital as well. This means that art consumers have to engage in a learning process in order to be able to value art. Consequently, the ability to appreciate art becomes a function of past art consumption and artistic goods are turned into addictive commodities. For instance, to derive utility from looking at the cadaver of half a cow swimming in alcohol requires background information and knowledge on the artistic message Damien Hirst is trying to convey. And the more one knows about Hirst, the more one can appreciate his works.

The Stigler-Becker model provides an explanation as to why individuals focus on certain artists and do not diversify indefinitely. Nevertheless, the model does not explain why individuals pick the same artists. The key concept in Adler's explanation of superstar phenomena is that art specific consumption capital is not only accumulated by consuming that particular kind of art, but also by interacting with other individuals. In order to be able to exchange knowledge with others, an individual has to search for likewise knowledgeable peers and this search creates costs. However, the more individuals patronize the same artists the lower the search costs. Hence, an individual is better off choosing the most popular artist because this artist is orbited by a large number of individuals who are knowledgeable about this artist. By linking the consumption of particular goods such as art with a discussion based learning process, Adler incorporates positive network externalities into the assignment problem formulated by Rosen. And due to these externalities, talent or quality is no longer the sole motive why consumers pick a particular artist. According to Adler's framework, popularity feeds popularity. Therefore, even in a context of equally gifted artists, superstars can arise because as soon as one artist is slightly more popular than his competitors everybody will end up consuming the goods of the same artist. Yet, if everybody chooses the same artist why are certain artistic fields occupied by more than just one star? Rosen explains the existence of multiple stars based on varying utility functions at different levels of consumption. At low levels of consumption, individuals prefer to specialize; at high levels of consumption, consumers prefer to diversify. Individuals who devote more time to art therefore have a greater set of stars.

Interestingly, Adler's explanation of stardom not only reveals how stars emerge in a context of homogeneous talent, but also why stars are not necessarily the most talented of their kind. This phenomenon is due to the fact that the lower quality of a superstar compared to the talent of an unfamiliar rookie is compensated by lower costs which consumers have to bear when searching for discussion partners and accumulating consumption capital. Consequently, the framework proposed by Adler suggests that superstar phenomena are marked by great stability since the increasing popularity of a star lowers the possibility of a more talented newcomer challenging his position.

What Adler's model does not explain is why one member of a group of equally talented artists will eventually be promoted to superstar. A later paper by the same author fills that gap. Following Adler (2006, 5), becoming a superstar is no longer a matter of talent and luck, but also of publicity. Artists deliberately use publicity, for instance appearances on TV shows or coverage in magazines, to signal their popularity to consumers and convince them to hop on the bandwagon.

2.3 Empirical Evidence

As Krueger (2005, 18) stresses, the key challenge of empirically analyzing the mechanisms behind the creation of superstars lies within a suitable measure that appropriately reflects the talent of a producer or the quality of goods he is offering. In his studies of the American record industry, Hamlen (1991, 1994) uses voice quality, which captures the depth and richness of a singer's vocal skills and is measured based on harmonic analyses, as proxy for talent. The studies contradict the results of Rosen's model by revealing that, in terms of record sales, hit singles and hit albums, small differences in talent do not translate into magnified increases in success and income. The study shows that singers are rewarded for superior talent, but that these rewards are in fact disproportionate to their superiority in talent. Schulze (2003, 434) argues that Hamlen's failure to find empirical evidence for Rosen's superstar explanation is due to an omitted variable bias because voice quality does not appropriately reflect the talent of a non-classical singer or the quality of his music. Schulze acknowledges however that overcoming this obstacle of finding the right measure for talent and quality is a demanding task since other factors that potentially influence success such as charm or lyrical content are difficult to capture. Krueger (2005) applies an alternative, less conventional measure for artistic quality. He measures talent based on the length of print columns devoted to each artist in "The Rolling Stone Encyclopedia of Rock & Roll" and comes to the conclusion that the dynamics of artists' revenues are only partially consistent with Rosen's predictions.

Chung and Cox (1994) study the relevance of Adler's superstar model in the music industry. Based on a stochastic model, their investigation unveils that stardom does not require the heterogeneous distribution of talent.[4] Chung and Cox show that the distribution of gold records is best described based on distributions which result from a stochastic model of Yule (1924) and Simon (1955).[5] This model shows that the probability for an individual picking a particular record increases with the number of individuals who have previously picked this record. The model also implies that a record which has not been previously selected is chosen with constant probability. The fact that the distribution of record sales corresponds to the distribution predicted by the stochastic model leads Chung and Cox to the conclusion that superstar phenomena do not require differential talent; therefore, becoming a superstar is rather a question of luck than of talent. However, as Schulze (2003, 434) points out, even if consumer's choice of records does follow the distribution implied by a particular probabilistic model, Chung and Cox fail to answer the question as to why consumers pick a particular record.

The results presented by Ginsburgh and van Ours (2003), who examine the "Queen Elizabeth Piano Competition", could also be interpreted as proof for Adler's line of argumentation that stardom is not necessarily the result of superior talent. The authors present empirical evidence that the order in which artists perform at the competition influences the outcome of the competition and that the outcome of the competition affects the artists' future success. What is stunning about these findings is that the order in which artists perform is randomly assigned. Consequently, the study by Ginsburgh and van Ours seems to substantiate Adler's case that luck not talent is the key ingredient in superstar creation.

Franck and Nüesch (2010) investigate superstar phenomena outside the realms of the performing arts and analyze whether stardom in soccer is driven by talent or popularity.[6] Their empirical study shows that a player's market value depends on his talent, which supports the Rosen view, but is also driven by non-performance-related popularity which Franck and Nüesch measure based on individual press citations. The latter finding substantiates Adler's superstar theory. Ehrmann, Meiseberg and Ritz (2009) explore yet

[4]Giles (2006) as well as Spierdijk and Voorneveld (2009) empirically investigate the emergence of superstars based on a similar approach.

[5]This model has been proposed by Yule and Simon as a probability mechanism which explains a variety of empirical data such as the distribution of income or the number of publications per scientist.

[6]Further studies of stardom in soccer include Lucifora and Simmons (2003), Franck and Nüesch (2008), Lehmann and Schulze (2008).

another non-artistic sector: Deluxe gastronomy. In their study, quality is captured based on reviews by "Guide Michelin" and "Gault Millau", the two leading restaurant rating institutions, and TV presence is used as a proxy for popularity. In contrast to the findings by Franck and Nüesch, Ehrmann, Meiseberg and Ritz fail to find empirical evidence for superstar effects induced by both quality and popularity. TV appearances do have a positive impact on chefs' financial rewards but this effect seems to be only moderate.

Salganik, Dodds and Watts (2006) examine the talent-versus-popularity debate in a controlled laboratory environment in which participants of an experiment were asked to download songs. One group was given information about which songs had been downloaded by other participants while the other group had no knowledge on other participants' downloading behavior. The results of the experiment indicate that observing other individuals' behavior increases the skewness of distribution underlying consumer choice as well as the predictability of which artist is turned into a superstar. These findings provide a first indication of what will be further discussed in the following section: That the influence of observational learning on consumer behavior plays a significant role in superstar formation.

3 Superstars from a Cascade Perspective

3.1 Theoretical Considerations

The empirical evidence outlined above does not provide a consistent answer to the question whether the actual emergence of superstars can be explained either based on the model proposed by Rosen or by applying the framework presented by Adler. With regard to the Rosen set-up, inconsistent empirical results might be due to the fact that Rosen-style stardom requires a hierarchy in talent and a production technology that allows for scale economies. One might argue that consumers often face a group of providers of the same good which are perceived to have equal quality. Since very small differences in quality are sufficient to win the race, this limitation might be viewed as a minor one. The second limitation, however, is significantly more constraining since the concept of scale economies or mass joint consumption does not apply to all markets. For example, the reason why Ehrmann, Meiseberg and Ritz (2009) fail to find empirical proof for superstar effects in a Rosen-sense might be simply due to the limited applicability of scale economies resulting from joint consumption in the fields of gastronomical services. The service provided by a deluxe restaurant still exhibits the characteristics of a club good, and congestion costs rise quickly once the number of clients equals the maximum seating capacity. The same applies to star coiffeurs, to star surgeons or to star lawyers, just to pick a few illustrative examples. Therefore, Rosen's model does not explain why superstars emerge in markets which do not permit the consumption of "canned" goods as in music, sports, or motion pictures.

One assumption however, which is fundamental in Rosen's as well as Adler's superstar model, results in the greatest limitation with regard to the application of these models which have so far dominated the debate. Rosen as well as Adler base their explanation of stardom on the assumption that consumers have perfect information about the talent of the producer of a particular good. In other words, both models assume that consumers make their decision while having complete transparency with respect to the quality of goods that are offered. Yet in most decision situations, consumers have to choose a product or service in a context which is marked by decision uncertainty regarding the actual decision consequences in terms of payoff or utility. A framework that explains decision behavior of individuals who face decision uncertainty has been presented by Bikhchandani, Hirshleifer and Welch (1992) and simultaneously by Banerjee (1992). In these seminal papers, the authors show that individuals who have only imperfect knowledge about the true value of an underlying state variable and who can observe other individuals' decisions eventually choose to ignore their private information and herd into the same direction. This herding phenomenon is called informational cascade. An individual who is subject to an informational cascade "makes a decision based on observation of others without regard to his own private information" (Bikhchandani, Hirshleifer and Welch (2005)).

Three attributes of the decision context are key in order to serve as a basis for the emergence of informational cascades. First, individuals decide sequentially. Second, individuals can only observe the decision of other individuals and not their private information.[7] And third, the decision space from which individuals chose needs to be discrete so that the decision of an individual

[7]Following Bikhchandani, Hirshleifer and Welch, this attribute is of minor relevance since generally "action speaks louder than words" (Bikhchandani, Hirshleifer and Welch (1992), 1009).

does not reflect his complete set of information (Gale (1996), 621). All requirements are generally met in fields in which superstars are met and which have been investigated in the stardom debate so far, such as record or box office sales. And in fact, a number of papers have established the link between informational cascades and stardom or phenomena similar to stardom. For instance, Bikhchandani, Hirshleifer and Welch (1992, 1013) link cascades and stardom by stressing the relevance of early offers on the success of job applicants. Interestingly, Bikhchandani, Hirshleifer and Welch point out that individual stardom caused by cascade behavior can be unstable (Bikhchandani, Hirshleifer and Welch (1992), 1014). This point will be further discussed in section (3.2). De Vany and Walls (1996) show that the supply and demand economics of motion pictures are subject to informational cascades, and that information feedback among film audiences contributes to the emergence of "hits" and "flops". Salganik, Dodds and Watts (2006, 855) point out that the results of their experimental study, which has has been presented in section (2.3), indicate that collective behavior in cultural markets seems to be subject to phenomena which are similar to informational cascades. Despite this evidence, the superstar debate still focuses on the explanations advocated by Rosen and Adler and seems to discard the fact that consumer choice is often affected by decision uncertainty. The following simple model shows how superstars emerge due to informational cascades, and illustrates the relevance of cascades as an explanation for superstar phenomena in markets in which the quality of goods is not perfectly revealed to consumers.

Assume a simple economy which is similar to the one described by Adler (1985). The economy consists of identical consumers, risk-neutral maximizers of expected payoff, and two non-identical producers of a particular good denoted by X and Y.[8] By definition, individuals can either consume the good that has been produced by X or by Y and cannot split their consumption on both producers. Decisions are made based on a sequential decision process. This means that consumers decide one by one whether to choose producer X or to go for producer Y. The order in which individuals make their decision is exogenously determined and random.

One producer has superior talent and consequently offers a good that is of

[8] The setting described here is based on the setting presented by Bikhchandani, Hirshleifer and Welch (1998) to show how the decision rationale of individuals who have to decide whether to adopt or reject a certain behavior is impacted by informational cascades.

higher quality, which leads to a greater payoff when being consumed.[9] There is an equal prior probability of $\frac{1}{2}$ that either X or Y turns out to have superior talent. Consuming the good by the more talented producer yields a payoff of 1, whereas the consumption of the good by the less gifted producer results in a payoff of 0. It is evident that given these parameters every individual prefers consuming the high quality good, and is therefore interested in picking the right producer.

Every individual i observes a signal s_i which is either $s_i = x$ or $s_i = y$. The probability to observe either signal is dependent on which of the two producers is in fact the more talented. If X proves to have superior talent then a signal x is observed with probability p and a signal y is observed with probability $1-p$. The signal is informative with $p \in (\frac{1}{2}, 1)$. If the contrary holds true and X is in fact the producer with inferior talent, then signal probabilities are reversed. Consequently, the probability for observing a signal x is $1-p$ and a y is observed with probability p. Is is assumed that every individual has the same knowledge with regard to the respective talent of the two producers, and thus observes either signal with equal probability p. Table (1) provides a summary of probabilities in this setup.

Table 1: Overview of probabilities

Probability	X	Y
Unconditional probability that producer ... has superior talent	$\frac{1}{2}$	$\frac{1}{2}$
Conditional probability that producer ... has superior talent when signal $s_i = x$ is observed	p	$1-p$
Conditional probability that producer ... has superior talent when signal $s_i = y$ is observed	$1-p$	p

In contrast to the model presented by Adler, consumers are not able to discuss and share their knowledge with other individuals. Therefore, an individual has no information on the signals which other individuals have observed.

[9] As has already been stressed in the introduction of this dissertation, it is assumed that a talented individual automatically produces high quality goods and that goods of high quality can only be produced by talented individuals.

However, every consumer can observe whether preceding individuals in the decision sequence have chosen to consume the good by X or art by Y. The history of decisions before individual i is making his decision is denoted by A_i. The information inferred from observing other individuals' behavior is combined with private information to determine the expected payoff of selecting the respective producer. If the payoff of consuming the good by X is denoted by Π^X, then $E[\Pi^X] = \gamma^X$ with γ^X being the posterior probability that X is the producer with superior talent based on Bayesian rationale. When consuming art by Y then $E[\Pi^Y] = \gamma^Y$. In this case, γ^Y is the posterior probability that Y is the more talented of the two producers.

For the first consumer in the decision sequence the case is quite simple since he bases his decision solely on his own private signal. If he observes an x, then $E[\Pi^X] = p$ and $E[\Pi^Y] = 1 - p$. With $p \in (\frac{1}{2}, 1)$ it follows that $E[\Pi^X] > E[\Pi^Y]$ and consequently he decides to consume the good by X. Similarly, observing a y would convince him to favor producer Y. In both cases, once his decision has become public information, consumers later in the sequence can perfectly infer from his decision which signal he has observed. His decision thus improves the pool of public knowledge and helps other consumers to pick the producer with greater talent. If the second consumer observes the same signal as the first individual then he will join his predecessor and decide to consume the good that is offered by the same producer since, following Bayesian inference, his private signal has further increased the expected payoff of consuming the good that has been produced by that producer. If, however, the second consumer observes a signal which is contrary to the first signal then $E[\Pi^X] = E[\Pi^Y] = \frac{1}{2}$. By assumption, an individual who is indifferent between the two goods tosses a coin to make his decision and therefore picks either producer with equal probability $\frac{1}{2}$. The third individual faces three possible situations: 1) Both individuals have chosen to consume the good by X, 2) both individuals have picked the good by Y, or 3) one individual has selected X and the other one has opted for Y. In the first case, the third individual will also make his decision in favor of X. In fact, this decision is independent of his own private signal because $E[\Pi^X] > E[\Pi^Y]$ no matter if he observes an x or a y. The same rationale applies to the second case. Despite his private information, if both predecessors have opted for Y then $E[\Pi^Y] > E[\Pi^X]$ and he will pick Y as well. With respect to the third situation, he infers that one consumer must have observed an x and the other consumer must have seen a y. Since both signals balance out, the third individual is in the same position as the first individual. He will therefore entirely rely on his private information and decide accordingly. In the first two cases, consumer number three is subject to an informational cascade because his decision is solely based on the decisions he has observed, and his private signal is no longer included in his individual decision rationale. As a result, since everybody knows that his behavior is not affected by his signal, his decision does not improve the pool of public information. In both cases, every following consumer will, based on observational learning and independent of private information, choose the same producer. This producer then becomes the superstar and, due to cascade behavior, offers his good to the entire market and is in return rewarded with extraordinary income.

If, for example, producer X has superior talent and due to an informational cascade every individual eventually consumes the good that he has produced, the cascade induces individuals to make the right decision and choose the option which in fact maximizes their payoff. But what if everybody ends up buying the good by X despite the fact that Y is the producer with greater talent? The following simple calculation shows that there is a high chance that the producer with inferior talent becomes the superstar even though every consumer is behaving perfectly rational. As Bikhchandani, Hirshleifer and Welch (1992, 998) show, the probability that a correct cascade, which induces individuals to choose the option which is in fact payoff maximizing emerges after two individuals have already made their decision is

$$\frac{p(p+1)}{2} \tag{1}$$

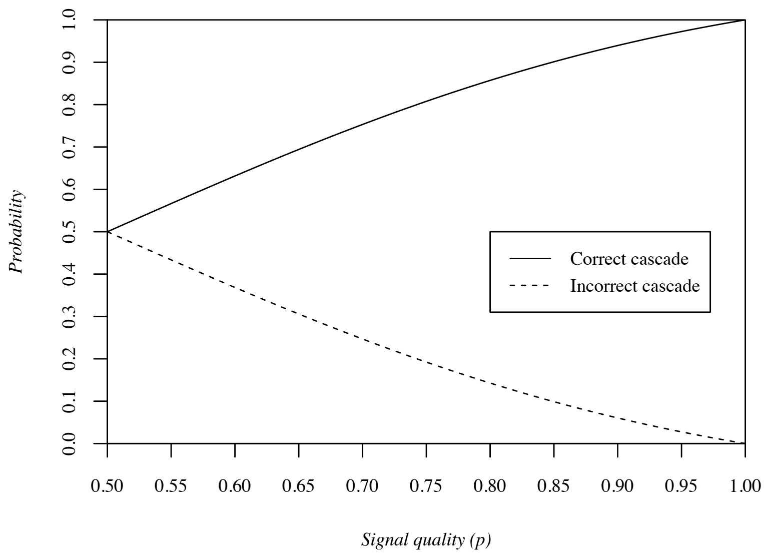
And the probability of an incorrect cascade after the first two individuals is

$$\frac{(p-2)(p-1)}{2} \tag{2}$$

Equations (1) and (2) show that the probability for a correct cascade or an incorrect cascade at a given point in time in the decision sequence depends entirely on the quality of private signals and thus on how much knowledge individuals have about the talent of a producer. Suppose that $p = 0.8$ and therefore that a consumer only trusting his own private information would pick the producer with greater talent with a probability of 80 percent. Given this level of signal quality and given that an informational cascade has already formed, there is still more than a 14 percent chance that this cascade is incorrect and induces an individual to join a herd which turns the wrong producers into a superstar. In this case, even though consumers collectively make the wrong decision from an individual point of view, joining the herd is rationally the right choice. Figure (1) illustrates the impact of signal quality on the emergence of correct and incorrect cascades.

Figure 1: Cascade probabilities (I)

The figure presents the probability of a correct cascade, which induces individuals to choose the superior option, and an incorrect cascade, which convinces individuals to pick the inferior option, as a function of signal quality p.

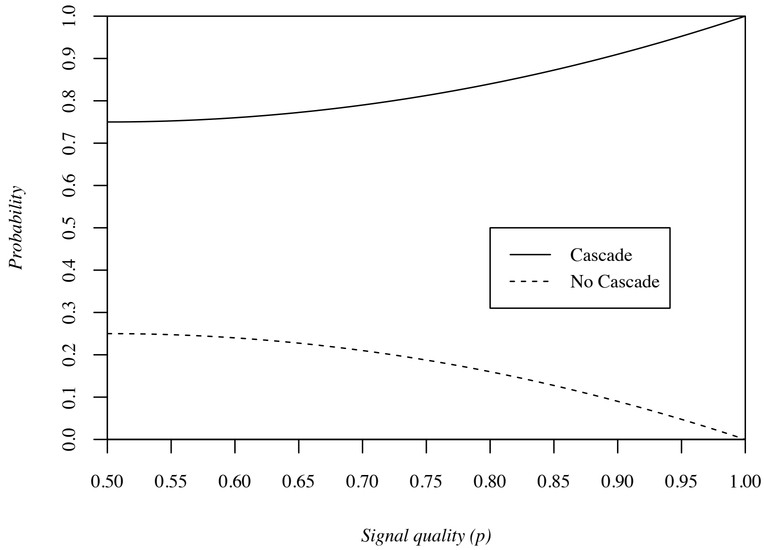


The simple model presented above outlines how superstar phenomena in an environment marked by decision uncertainty can be explained based on informational cascades. Yet, what seems contradictory is that a high level of decision uncertainty would imply that individuals observe private signals marked by low quality, and as Bikhchandani, Hirshleifer and Welch (1992, 997) show, the lower the signal quality the lower the probability that cascade behavior develops. Following Bikhchandani, Hirshleifer and Welch, the probability that no cascade occurs after an even number of individuals n that have already made their decision, e.g. whether to consume the good by X or by Y, is $(p - p^2)^{n/2}$. It follows that this function is increasing in n and p. Hence, the longer the decision sequence and the closer the quality of signals is to 1, the higher the probability that cascade behavior emerges. The closer p is to

$\frac{1}{2}$, means that less information is being conveyed by a signal, thereby taking a longer time for cascades to form. Figure (2) illustrates how signal quality impacts the probability that no cascade emerges after two individuals have already made their decision.

Figure 2: Cascade probabilities (II)

The figure illustrates the probability that a cascade forms and that no cascade forms after two individuals have made their decision as a function of signal quality p.



However, the formation of informational cascades is not only driven by the knowledge individuals have about the true value of an underlying state variable, but also by how this knowledge is distributed among individuals. The basic set-up outlined above assumes that every consumer observes private signals with the same probabilities. A more realistic setting would imply that individuals have heterogeneous knowledge about the talent of X or Y, and thus observe signals based on varying conditional probabilities. Bikhchandani, Hirshleifer and Welch have labeled individuals with information of higher quality "fashion leaders". The impact of fashion leaders on the formation of informational cascades depends on the position of these individuals in the decision sequence. Suppose that in the economy outlined above, a consumer with private information of slightly higher quality on the talent of X and Y is the first in the decision sequence and that everybody knows about his superior knowledge. In this case, the informational cascade starts immediately because every consumer will trust the expert and copy his behavior. If a fashion leader is positioned later in the decision sequence, he is more inclined towards following his private information and might thus, depending on the informational advantage he has, break an informational cascade that has already formed. Suppose that consumers not only have heterogeneous private information about the talent of X and Y, but are also given the right to decide when to make their decision. In such a setting, waiting provides an informational benefit because more decisions of fellow decision makers can be observed. But if waiting is costly, then consumers have to weigh the benefit of waiting against its costs. Zhang (1997, 196) shows that, if decision timing is exogenous, fashion leaders move first because due to their informational advantage waiting is relatively less rewarding. Consequently, fashion leaders, because other individuals are quickly convinced by their informational superiority, accelerate the emergence of informational cascades. Thus, a high degree of decision uncertainty does not reduce the influence of cascades on consumer behavior if knowledge is heterogeneously distributed and some individuals have, or at least are perceived to have, superior knowledge.

Consumers in the model presented above have to make a binary decision, i.e. to pick producer X or producer Y. It should be noted, however, that the model of informational cascades does not only apply to simple this-or-that decision situations in which for example individuals have to choose between two products, or between adopting or rejecting a certain behavior, or between voting left or right. Cascade frameworks equally explain herding phenomena in settings where decision makers face more than just two options. For example, the economy described above can be extended to include more than two producers. As long as the set of options shows some level of finiteness, informational cascades still form. The emergence of superstars would simply take longer since a larger set of options delays the moment at which the information gained by observing other individuals' behavior outweighs private information (Bikhchandani, Hirshleifer and Welch (1998), 159; Gul and Lundholm (1995), 1057). Informational cascades also provide a basis for explaining the emergence of more than just one superstar. Multiple superstars emerge when individuals have heterogeneous preferences. In this case, given that preferences are public information, an individual simply includes the information on other individuals' preferences in his observational learning (Bikhchandani, Hirshleifer and Welch (1998), 161). This might eventually lead to the emergence of multiple cascades, thus leading to multiple superstars. Independent of option set or preferences, the basic mechanism stays the same: The less consumers know about the quality of a good the more they observe how other individuals are behaving, especially if other individuals are expected to have superior knowledge, and thus the bigger the influence of informational cascades. It is therefore assumed that superstars who have been brought up by cascade behavior, are especially prominent in markets where transparency with regard to the talent of producers or the quality of their goods is very low.

3.2 An Extended Cascade Model

A key symptom of herding behavior that has been caused by informational cascades seems to restrict the application of cascade models as explanatory basis for superstar phenomena. Classic cascade theory indicates that herding caused by informational cascades is fragile and quickly reversed (Bikhchandani, Hirshleifer and Welch (1992), 1004). The reason why cascades are easily shattered lies within the fact that, once a cascade starts, no more public information is accumulated and decisions no longer contain informational value for following decision makers. Hence, the information basis remains fairly small. As a result, the arrival of new information, either because a public institution has released new information or because a better informed individual, i.e. a fashion leader, has entered the scene, can easily break cascade behavior (Bikhchandani, Hirshleifer and Welch (1998), 157). In contrast to what classic cascade models would predict, markets that are subject to imperfect information do not only exhibit short-lived stardom based on quick hypes and fads, but are also characterized by stable superstar phenomena.

Cascades that are characterized by increased stability can only be explained when analyzing collective decisions based on models which extend the classic BHW setting. One extension has been proposed by Rohner, Winestein and Frey (2006) who include the consumption capital concept of Stigler and Becker into the BHW model. In their analysis of herding in the fields of arts and culture, the decision of museum visitors whether to visit an exhibition on Old Masters or Impressionists is affected by informational cascades. The model presented by Rohner, Winestein and Frey results in stable cascade behavior because the visit of a particular exhibition leads to the accumulation of consumption capital. The more capital a visitor has accumulated, the higher the chance that he observes a particular signal which induces him to visit a particular exhibition. Hence, consumption capital has a direct impact on the informational setting of the model. However, this model requires that the decision-game is repeated. It therefore fails to explain why an individual, that has never entered a museum before, might still be more inclined to see an Impressionist exhibition. It therefore does not provide a suitable theoretical basis for examining why Michael Jackson is turned into a superstar by individuals who have never listened to his music before.

Another extension of the BHW framework that explains stable cascade behavior has been proposed by Walter (2002). In this model, the payoff which individuals receive based on their decision consists of two elements. The first element corresponds to the payoff structure of the BHW model, and therefore depends on the true value of an underlying binary state variable. The second element, which Walter terms the externality payoff, only depends on individuals' behavior, i.e. on how many individuals have rejected or adopted. Consequently, the decision of an individual directly affects the payoffs of fellow decision makers. Walter shows that adding this element to individuals' payoff function significantly increases the stability of cascade behavior (Walter (2002), 64). Because even if an individual making his decision later in the decision sequence has more precise information on the true value of the underlying state variable, or if new public information is released during the sequence, it might still be the payoff maximizing option for an individual to follow the cascade due to the payoff which is collectively determined by the entire group. These theoretical findings are in line with the experimental results presented by Drehmann, Oechssler and Roider (2007) that show that cascade games which include positive payoff externalities produce more robust cascades.[10]

This paper believes that the reason for the higher stability of cascade-based stardom lies within the combination of informational externalities and positive payoff externalities. First, because as Drehmann, Oechssler and Roider (2007, 392) point out, many real world situations are subject to both types of externalities. And second, because of the particular relevance of positive payoff externalities in decision contexts in which superstar phenomena occur. The first reason for this particular relevance has already been presented by Adler: Positive payoff externalities arise because of how consumers acquire consumption capital. The second reason is that the consumption of many goods, especially

[10] Similar experimental studies include those by Hung and Plott (2001) and Owens (2010).

of those goods that are exchanged in markets which are subject to phenomena of stardom, is characterized by what Leibenstein (1950) calls bandwagon effects. Due to these effects, consumers receive a relatively higher payoff from consuming commodities which are considered trendy. Therefore, in order to better reflect consumer behavior in markets in which superstars generally occur, the basic BHW model is combined with positive payoff externalities.

The BHW model is adjusted in a way that is similar to the approach proposed by Walter. The payoff function of consumers no longer depends solely on the true value of an underlying state variable, but also includes an externality payoff. In the model presented here, the externality payoff depends on the popularity of a particular producer k which is denoted by P^k. As a result, an individual assessing the expected value of consuming a good by producer k has an expected payoff of

$$E[\Pi_i^k] = \gamma_i^k + P_i^k \tag{3}$$

The payoff component γ_i^k which depends on the true value of the underlying state variable V is determined exactly as in the model outlined in section (3.1). And the second payoff element, which is tied to the popularity of a producer, is solely a function of the number of consumers j who decide to consume the good offered by producer k. Hence, in contrast to Adler, payoff externalities directly increase the payoff of consuming a particular good and do not decrease consumption costs. And in contrast to the approach of Rohner, Winestein and Frey, this paper presents an adjustment to the BHW model with respect to individuals' payoffs and not to their private signals.

The model presented by Walter (2002, 41) is based on two crucial assumptions: First, every individual decision has the same marginal effect on externality payoffs. For example, the increase in externality payoff after the first individual of the decision sequence has decided to consume a particular good is the same as the increase after the tenth individual has decided to consume the same good. And second, the externality payoff which an individual receives depends on the decisions of preceding as well as following individuals. While these assumptions apply to certain decision situations, they are not generally applicable to a context of consumer behavior. With respect to the first assumption, in order to capture the relevance of bandwagon effects, this paper expects that the impact of a consumer's decision on other consumers' payoffs depends on whether this consumer is among the early adopters or whether this consumer finds himself among the late followers. And regarding the second assumption, the model here assumes that the externality payoff a consumer receives only depends on the behavior of his predecessors. This reflects that, from the perspective of consumption capital as well as trend effects, a consumer has a stronger interest in those consumption decisions that have already been made. The externality payoff P_i^k is therefore specified based on the following logistic function:

$$P_i^k(j) = \frac{1+q}{1+qe^{-\beta j}} - 1 \tag{4}$$

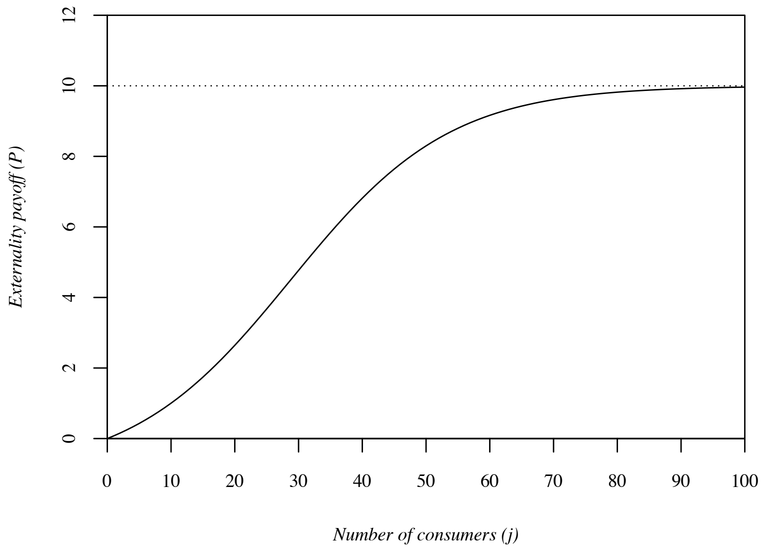
This function is solely dependent on variable j, which captures the number of individuals who have consumed the good offered by producer k before individual i is making his decision and the two parameters q and β. Parameter q defines the maximum payoff that individuals receive based on the popularity of the producer. And β determines how fast the externality payoff increases. Based on a specific set of parameters, figure (3) illustrates how externality payoffs change with the number of individuals consuming the good by the same producer.

Function (4) has some important characteristics. First, if consumer i is the first to pick a particular product then $P_i^k(0) = 0$. Second, the marginal impact of consumer i choosing a particular good on the externality payoffs of following individuals choosing the same good depends on j. In the early phase of a producer's popularity building process, every consumer choosing this producer's good has a marginal impact on his popularity that is increasing. However, at one point in time, the trend component of this good wears off and the marginal impact decreases. Third, the rate at which externality payoffs increase depends on the maximum payoff q. The higher q, the longer it takes until consumers fully benefit from a producer's popularity.

As has already been pointed out, informational cascades are easily shattered because they are sensitive to informational shocks. They break either because: 1) a better informed individual deciding later in the decision sequence makes a decision which does not correspond to the behavior indicated by the cascade, or 2) new public information is released which improves individuals' pool of information and therefore their decision basis. Both shocks have been excluded by the assumptions of the model, but shall nevertheless be examined

Figure 3: Externality payoff

This figure illustrates how the externality payoff of a consumer increases with the number of consumers that have already chosen the good by the same producer based on payoff function (4) with $q = 10$ and $\beta = 0.08$.



in the following.

In order to analyze the stabilizing effect of positive payoff externalities on cascade behavior with respect to better informed individuals, assume that in the economy outlined above the first individual has decided to consume the good offered by producer X. Even if the second consumer observes a y signal, he would still follow his predecessor's behavior and is already in an informational cascade because, since the two signals cancel each other out, he receives a positive externality payoff which induces him to consume the good by X as well. This result is in line with the findings by Walter (2002, 58). And even though this decision no longer carries informational value, in contrast to the classic BHW setup, it has further increased the popularity of X and thus the payoff of following individuals consuming his good. By assumption, one of the later individuals in the decision sequence is a fashion leader and therefore observes a signal y that is marked by higher signal quality. Assume that $\hat{p}$ denotes the signal quality of the fashion leader, and that signal quality p is public information. If this individual is indifferent between joining and braking the cascade it follows that

$$\gamma^X + P^X(j) = \gamma^Y \tag{5}$$

And therefore

$$\hat{p} = \frac{p\left(P^X(j) + 1\right)}{P^X(j)(2p-1) + 1} \tag{6}$$

Since equation (4) is increasing in j, equation (6) is increasing in j as well for all $p \in (\frac{1}{2}, 1)$. This means that, the later the fashion leader makes his decision after a cascade has already started, the higher the signal quality of the fashion leader that is needed to break the cascade. As a result, popularity makes the cascade more robust, and the longer the cascade continues the lower the probability that it is broken by better informed individuals.

Once again, assume that the first individual has decided to consume the good offered by producer X in order to illustrate the effect of a public information disclosure on cascade behavior that is affected by positive payoff externalities. After this consumer's decision, a cascade emerges which leads every following consumer to copy his behavior. If a public institution releases a signal y that is visible to all consumers and which is as precise as consumers' private information, then an individual after this information disclosure would still follow the cascade independent of his private signal as long as

$$p < \frac{1+q}{1+qe^{-\beta j}} \tag{7}$$

As a result, the higher the externality payoff, the higher the level of signal quality which is required so that a public information disclosure breaks a cascade. In conclusion, positive payoff externalities increase the robustness of cascade behavior, with respect to better informed individuals as well as new public information. These findings are in line with the results of Walter (2002, 65). In contrast to the approach by Walter, externality payoffs as they are defined based on equation (4) make cascade behavior more sensitive to informational shocks in the initial phase of a cascade. First, because the externality payoff of an individual only depends on the decisions of those individuals who have already made their decision. And second, because the first decisions have a lower marginal impact on externality payoffs than in the model presented by Walter. Hence, in contrast to the model by Walter, the popularity of a producer is marked by higher fragility in the beginning of his career and therefore by greater risk that the cascade breaks and that he is not turned into a superstar. However, if individuals are assumed to have homogeneous private information, and if releases of public information are excluded, then both models produce similar results.

The extended model not only reveals why cascades might lead to stable herding and stardom phenomena. In line with the results presented by Walter (2002, 84), payoff externalities also accelerate the development of herding behavior since, as the findings presented above show, the decision of the first individual is immediately copied by following individuals. However, the question is whether herding behavior which forms in this specific model can still be referred to as an informational cascade. As has already been explained earlier in this paper, an informational cascade signifies imitative behavior which emerges because the observed decisions of others induce an individual to ignore his own private information and follow the bandwagon instead. In the model presented above, the second consumer immediately imitates the behavior of the first consumer. However, he does this because of the externality payoff. Without this payoff, and in the case of a signal which does not correspond to his predecessor's decision, he would have been indifferent between both options and therefore would have tossed a coin to make his decision. Consequently, one might raise the question whether in this case herding behavior is actually caused by informational externalities or by payoff externalities.

In conclusion, by including payoff externalities in the cascade model of Bikhchandani, Hirshleifer and Welch, cascades become more robust to informational shocks, and therefore provide an appropriate theoretical fundament for explaining stable superstar phenomena. The extended model has also revealed that payoff externalities accelerate cascade formation. However, the examination of informational cascades in combination with payoff externalities also points to the key problem of empirically studying herding behavior, and the relevance of informational cascades as trigger for such behavior. As Gul and Lundholm (1995, 1056) point out, as soon as a combination of different mechanisms contribute to the formation of herds, it is difficult to investigate what has actually caused them and whether informational cascades contributed significantly to the clustering of decisions.

3.3 Efficiency of Cascade-Based Stardom

Based on his explanation of stardom, Adler (2006, 5) argues that superstar phenomena potentially lead to inefficient outcomes because prices are set in markets where producers face entry barriers. According to Adler, because the consumption of artistic goods leads to positive network externalities and because individuals look for those artists with the largest group of devotees, a newcomer of equal talent as the superstar can no longer win the market by offering his products at a lower price.

The same applies to superstars that have been created by informational cascades. As Bikhchandani, Hirshleifer and Welch (1998, 163) point out, outcomes of decision behavior that has been caused by informational cascades is less efficient than the result of a scenario in which consumers can directly observe other individuals' private information. If individuals have to infer other individuals' private information from their behavior, and if behavior is bound to a discrete set of choices, information is lost on the way and the accumulation of public information is restrained. As a result, informational cascades weaken positive informational externalities and might not only lead to market outcomes where the less talented become superstars, but also where the superstars successfully defend their market share against more talented individuals.

In order to overcome the negative effect of cascades on the transmission of information, consumers could be allowed to communicate and exchange private knowledge. However, due to problems of credibility, individuals would still be inclined towards information deduced by observed behavior since, as Bikhchandani, Hirshleifer and Welch (1998, 1009) argue, "action speaks louder than words". Consumers could also be given the opportunity to buy additional information which enhances their pool of private information. For example, an individual could invest additional time or money in gathering further information about the true quality of a particular surgeon in order to improve his judgement. According to Feltovich (2002, 5), a setting in which individuals have to buy private information further accelerates the formation of cascade behavior because individuals are even more inclined towards relying on the behavior of others in order to reduce information costs. In conclusion, it is unlikely that alternative decision mechanisms reduce the probability of cascade behavior and their impact on the emergence of superstars. Technological advances in communication, which increase transparency with respect to consumer behavior, will increase the prevalence of imitative behavior rather than support the transmission of private information (Bikhchandani, Hirshleifer and Welch (1998), 163).

However, in contrast to the BHW model, the positive payoff externalities included in the extended version of the model reduce the inefficiencies which result from cascade behavior. Even if decisions do not improve the pool of public information, they still increase the value of consuming a particular good. Yet, given that a superstar offers a good that is inferior in quality to the goods of his competitors and despite the fact that the crowd consuming his good has already turned him into a superstar, his popularity only partly compensates the inefficiencies caused by his inferior talent and does not fully eliminate the inefficiencies caused by herding behavior.

4 Stardom in Fine Art Markets

An economic field, in which informational cascades are expected to be particularly prominent, are the markets in which works of fine art are traded.[11] The distribution of auction volume, a suitable proxy for artists' earnings, indicates that rewards for artistic production are significantly skewed.[12] The Lorenz-curve shown in figure (4) indicates that a small group of artists accounts for the vast majority of auction volume while most artists have only a very small share in auction results. These facts point to the strong relevance of superstars in art markets. But how did these superstars emerge from the masses of unknown artists? This paper believes that cascade behavior is an important factor in the creation of artistic superstars. Cascades are expected to contribute significantly to the emergence of stardom because of the significant decision uncertainty which art consumers, i.e. buyers of works of fine art, face when deciding which works to acquire and at what price.

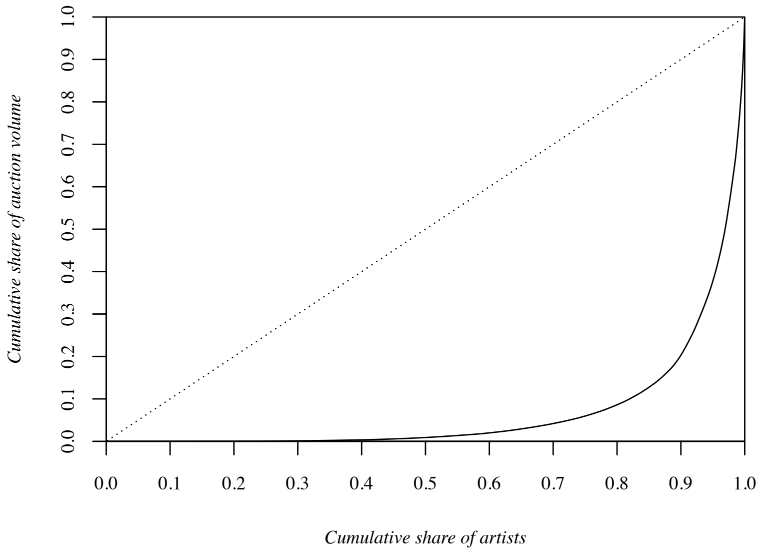
The fundamental economics of art markets are no different from the rules that govern conventional commodity markets in which, for instance, cars or oil barrels are traded. There is a supply side, represented by the artist, an art

[11] There is a multitude of different markets for fine art and numerous segmentation approaches, for example based on geographic provenience, materials used, artistic style, or period. In order to simplify the discussion, and avoid the segmentation debate, this paper examines fine art markets in general.

[12] Auction volume is determined based on the number of artworks sold in auctions and the respective price at which the works were sold.

Figure 4: Distribution of auction volume in art markets

This figure shows the Lorenz-curve for the distribution of auction volume (number of works times auction price) in 2009 for the top 800 artists of the ranking published by Artfacts.Net^{TM}on October 11, 2010. Artists with missing auction information were omitted.



dealer or an auction house, and a demand side, which predominantly consists of public institutions or private collectors. As Throsby (1994, 4) points out, individual actions on both sides are subject to "inconsistencies, spontaneity, and unpredictability in behavior", but aggregate behavior of market players can be explained through models that are in line with economic theory.

However, in contrast to conventional market settings or to what Downey (2008, 55) calls "crude supply and demand models", the consumption of art is characterized by a high level of valuation uncertainty. This uncertainty is due to the fact that works of art are unique, infrequently traded and cannot be valued objectively. There are no clear valuation rules that are simply based on demand and supply or on the physical characteristics of the works. Therefore, as Robertson (2005*a*, 228) puts it, the question is: "Does art have a fundamental value, and what are the elements that give it this value?"

The value of art can be broken down into two components: The first component is the intrinsic value of the artwork which is strongly tied to the individual buying it. The second component is the economic value which is agreed upon by the market. Economic value is, on the one hand, based on the physical characteristics of an artwork. Such characteristics include the type of artwork, e.g. sculpture or video installation, the choice of materials used or the size of the work. But even more important, the economic value of art is driven by its cultural quality which is not tied to tangible attributes but to the artistic concept that an artwork conveys. With regard to physical characteristics, it is quite obvious that a large sculpture is valued higher than a small sculpture of the same material. Or that paintings, due to their uniqueness, are generally valued higher than prints. But when it comes to cultural quality, the question arises how cultural quality is determined and who decides whether a certain art work is labeled high quality art or low quality art. Following Bonus and Ronte (1997, 110), the answer is: It is the public that decides. By recognizing the artistic abilities of an artist, the public decides on the quality level of his artworks (see as well Beckert and Rössel (2004), 37). Or, as Robertson (2005*c*, 4) concludes: "Art is only art if it has passed certain mechanisms." And Robertson (2005*b*, 22) notes that the recognition of an artist is the result of a social process which interlinks the different art market players such as dealers, curators, critics or collectors. All these market players participate in the reputation building of an artist and, as a result, contribute to the art valuation process. And according to Bonus and Ronte (1997, 112), this process is slow and path-dependent. Since the value of art is socially determined, consumers of art face significant uncertainty with regard to its current and, more important, its future value.

Due to the nature of the art valuation process and the valuation uncertainty it creates, it is expected that art consumers seek to reduce uncertainty by engaging in observational learning behavior. By observing the decisions of other market participants, art consumers try to gain further information on the talent of an artist and the quality of art he produces. Therefore, this paper expects that informational cascades have a relevant impact on the behavior of consumers of fine art and that cascades play a significant role in determining which artist becomes a superstar.

As has already been outlined, a crucial prerequisite for the emergence of informational cascades is the finiteness of the decision makers' action space. The pricing of artworks potentially provides consumers with the opportunity to adjust their action according to their private information (see e.g. Lee (1993), 410). But art prices are often artificially set and therefore do not simply correspond to supply and demand (see e.g. Velthuis (2003); Schoenfeld and

Reinstaller (2007)). Robertson (2005*b*, 18) argues, that the effect of demand on art prices is smaller compared to the impact of market approval. As a result, pricing in art markets does not seem to increase the richness of consumers' action space. In conclusion, the context in which art consumers have to decide which artworks to buy is expected to permit the emergence of informational cascades.

Due to the peculiar process of art valuation, consumers of art face very low transparency with regard to the quality of the different goods which are offered. As has been stressed above, a low level of transparency with regard to the quality of a good, delays the development of cascade behavior unless information is heterogeneously distributed among consumers. If one decision maker, the fashion leader, is believed to have superior information, then his behavior is quickly imitated by other decision makers, thereby instantly creating cascade behavior. Bonus and Ronte (1997, 110) and Bröker (1928, 16) stress the substantial influence of art insiders that are perceived to have superior cultural knowledge. It is expected that these experts act as fashion leaders, and that their presence accelerates the emergence of cascade behavior. In conclusion, art markets seem to be an ideal "breeding ground" for informational cascades, and thus for cascade-based stardom.

Figure (5) shows that those, who lead rankings by auction volume today, are the same artists which have dominated auction sales in the last couple of years, which indicates that stardom in art markets can be considered rather stable. The extended cascade model presented in this paper has shown that stable cascades arise when the decision of consumers not only result in informational externalities, but directly impact the payoff of other consumers as well. Both effects leading to positive payoff externalities, which have been mentioned in section (3.2), are of particular relevance in the context of fine art. Consumption capital is relevant because fine art, as Robertson (2005*c*, 3) puts it, is a learning and experience good and its consumption requires art specific knowledge. Rohner, Winestein and Frey (2006, 6) also argue that arts require specialized consumption skills which are acquired through learning. And since, according to Adler (1985, 208), the process of acquiring consumption capital is subject to effects that are similar to network effects, it is expected that art consumers are particularly interested in artists that are popular. Moreover, as Plattner (1998, 482) and Abbé-Decarroux (1995, 991) point out, the consumption of fine art is closely tied to the intention of demonstrating social status,

Figure 5: Auction performance of selected artists

This figure illustrates the auction performance of selected artists leading the artist ranking published by Artfacts.Net^{TM} on October 11, 2010. Auction performance of an artist is based on a ranking according to individual auction volume. The lower the rank of an artist, the better his auction performance.

prestige, and cultural interest. And therefore, the payoff of consuming a trend good such as fine art is strongly affected by bandwagon effects. Consequently, due to fine art being an experience as well as a trend good, cascade behavior in art markets is expected to be self-reinforcing. The more consumers that hop on the bandwagon, which turns a particular artist into a superstar, the more stable this herd becomes and the lower the chance that it is shattered by the arrival of new information that is either publicly released or included into the process by a better informed consumer.

One might argue that, in contrast to an incorrect cascade which induces consumers to dine at the low quality restaurant instead of the high quality restaurant across the street, the negative welfare effect of incorrect cascades that develop in markets for fine art seem to be of lower relevance since positive payoff externalities reduce the negative welfare effects of consumers herding behind mediocre artists. Yet, because informational cascades disturb the link between talent and reward, stardom based on cascade behavior is nevertheless not welfare maximizing if artistic resources are not optimally employed.

5 Conclusion

The superstar discussion has so far been conducted predominantly on the theoretical fundament established by Rosen and Adler. Rosen explains superstar phenomena based on differences in talent between producers and economies of scale in the production of certain products or services. According to Adler, superstars emerge because the consumption of certain goods requires consumption capital, and since the accumulation of consumption capital is subject to positive network externalities, buyers are better off patronizing the same producers.

The empirical testing of Rosen's, as well as Adler's, superstar explanations provides evidence for both models in different markets. However, numerous studies fail to find empirical proof for either model, indicating that alternative mechanisms might contribute to the emergence of superstars. Since Rosen's as well as Adler's model assume perfect transparency with regard to the quality of products or services provided, their explanations do not provide a suitable basis for exploring stardom in markets in which consumers face significant decision uncertainty with regard to the quality of goods that are offered.

This paper has outlined the relevance of informational cascade theory as theoretical fundament for explaining superstar phenomena in markets where consumers have only imperfect information about the talent of producers or about the quality of the products which these producers offer. Due to informational cascades, producers do not necessarily emerge as superstars because they provide goods of superior quality, but rather because consumers are not certain as to whether these producers actually offer a high quality good.

Building on earlier research, which combines the informational externality perspective of cascade theory with positive payoff externalities, this paper has presented an extended cascade model in which the decision of consumers directly impacts the payoffs of fellow consumers. In contrast to previous cascade models that include payoff externalities, the marginal impact of individuals' decisions on externality payoffs in the model presented here depends on whether an individual is an early adopter or a late follower. Moreover, externality payoffs are only dependent on the decisions of preceding individuals. Hence, externality payoffs increase at a lower rate in the beginning of a decision sequence which leads to an increased fragility of stardom in the early career of a superstar. In line with previous research, this model produces informational cascades that are marked by increased stability and continuity and therefore provide a suitable basis for explaining stable superstar phenomena.

Moreover, this paper has shown why superstars, that have been prompted by informational cascades, are expected to be particularly prominent in markets in which works of fine art are consumed. Cascades are expected to contribute significantly to superstar phenomena in these markets because of the exceptional decision uncertainty which art consumers face with respect to the quality and therefore value of fine art. But informational cascades as explanation for stardom do not only apply to markets of fine art. Cascade behavior might develop in any market where individuals make sequential decisions which are observable and which are bound to a discrete action space. It is therefore likely that cascade behavior contributes significantly to superstar phenomena outside the realms of fine art.

In order to further substantiate the theoretical findings of this paper, the true relevance of informational cascades in combination with positive payoff externalities as explanatory basis for the explanation of superstar phenomena should be tested based on empirical studies as well as experimental analyses. The second paper of this dissertation presents empirical evidence for cascade-based stardom in the markets for fine art. However, as this paper points out based on the statistical findings, the lack of micro information makes the clear identification of what has caused behavioral uniformity difficult. Therefore, testing the findings of this paper in a controlled laboratory environment, in which the decision and information space of consumers can be exactly specified, would contribute significantly to the further exploration of cascade-based stardom. Such experiments could build on the findings on how payoff externalities impact cascade behavior presented by Drehmann, Oechssler and Roider (2007) in combination with the experimental setup applied by Salganik, Dodds and Watts (2006) in their study of consumers' music downloading behavior. Such an approach would shed additional light on how superstars emerge if consumers face informational as well as payoff externalities.

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Superstars and Informational Cascades: An Empirical Analysis of Stardom in Markets for Fine Art

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Abstract: This paper empirically investigates whether stardom in markets for fine art is the result of cascade behavior among art consumers. The findings reveal that informational cascades contribute significantly to the formation of star artists and that the talent of an artist is of lower relevance. As the paper shows, these results particularly apply to the market for contemporary fine art. Moreover, the empirical evidence indicates that stardom in fine art markets is also driven by positive payoff externalities.

Keywords: Superstars, herding, informational cascades, art markets

JEL classifications: C32, D82, D83, Z11

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1 Introduction

Since the end of the Middle Ages, when artists started leaving the realms of anonymity and decorating their works with their signatures, the history of art has been a history of individual stardom and fame. But contrary to the announcement of pop-art star Andy Warhol, who stated that every individual is entitled to 15 minutes of fame, stardom has always been and still is reserved to a limited number of art producing individuals, and the majority of artists are never granted access to the limelight of prominence.[1] Those artists, who receive extensive public attention, whose auctions make the headlines and who, unlike their unknown colleagues, benefit from extraordinary earnings, are labeled superstars. These superstars are the subject of this paper.

How does an artist become a superstar? Two superstar models have significantly shaped the discussion on how stardom emerges. According to Rosen (1981), becoming a superstar is all about talent. And because of technologies that enable joint consumption, small differences in talent result in extraordinary earnings. Adler (1985) argues that superstars emerge because capital is needed to appreciate the consumption of particular goods such as art. Since this capital is acquired by interacting with other individuals, consumers end up patronizing the same producers offering these goods, thereby turning these producers into superstars.

The assumption which Rosen's as well as Adler's model share, is that consumers have complete transparency with regard to the talent of different producers or the quality of the goods between which consumers are able to choose. The first paper of this dissertation has outlined the relevance of informational cascade theory in explaining how superstars emerge in a market setting in which consumers have only imperfect information with respect to the quality of goods. Informational cascade models have been introduced by Bikhchandani, Hirshleifer and Welch (1992) and Banerjee (1992) to explain why individuals, who have to make a decision in a context of imperfect information, rationally choose to ignore their private information and copy the decision of other individuals instead. Such behavior leads to herding phenomena, and such phenomena can eventually create superstars.

Since the valuation of fine art is based on social interaction and lacks objec-

[1] Reference to Andy Warhol's famous quote "In the future everybody will be world-famous for 15 minutes".

tive valuation rules, decision uncertainty is significant and therefore superstars resulting from informational cascades are expected to be particularly prominent in these markets. Consequently, artists are turned into superstars not because they have superior talent, but because art consumers are uncertain whether an artist is in fact talented or not. This paper empirically investigates the relevance of informational cascades as explanatory framework for superstar phenomena in markets for fine art.[2]

The remainder of the paper is structured as follows. Section (2) outlines the stardom debate as well as the different models explaining the emergence of superstars. Section (3) reviews relevant empirical literature covering superstars as well as informational cascades. Section (4) presents the research hypotheses. Section (5) describes the data set, outlines the empirical methodology, and presents the empirical evidence regarding the relevance of informational cascades as explanation for stardom in fine art markets. Section (6) outlines the limitations of the findings. Section (7) concludes the results and presents potential paths for further research.

2 Theoretical Concepts

The theoretical fundament for the analysis of superstar phenomena has been established by Rosen (1981). Rosen investigates why certain markets are dominated by a small group of producers, labeled superstars, who account for the majority of market output and benefit from extraordinary earnings. He explains this dominance on the supplier side based on the imperfect substitutability of talent or quality in combination with technological developments that improve the production capabilities of these producers. Imperfect substitutability of talent means that "lesser talent is a poor substitute of greater talent" (Rosen (1981), 846), and implies that individuals prefer to consume fewer high quality goods than a larger number of low quality goods. Rosen argues that the imperfect substitutability with regard to talent or quality, which is applicable to all activities in which superstars are generally met, by itself explains convexity in earnings. Following Rosen, the second symptom of stardom, namely the concentration of output, stems from advances in production

[2] Despite the fact that general terms such as "art markets" or "art" are occasionally used in the remainder of the paper, this paper solely analyzes markets for fine art and therefore excludes other forms of art such as the performing arts or literature..

technology that enable the joint consumption of certain goods. Rosen claims that reproduction technologies have turned certain services into quasi public goods that are protected by the possibility to exclude non-paying consumers.

An alternative model explaining the formation of superstars, which together with Rosen's framework has dominated the stardom debate to date, has been proposed by Adler (1985). Adler's model does not require differences in the talent of producers, and is thus able to explain how stardom emerges in an economy marked by producers of equal talent. According to Adler, superstars emerge because the consumption of certain goods, such as music or literature, requires consumption capital, a concept which has been presented by Stigler and Becker (1977) to explain phenomena of addictive consumption. Stigler and Becker argue that before a consumer is able to appreciate a particular good, he must acquire consumption specific knowledge. This specific knowledge is acquired by actually consuming the good. Adler argues that consumers not only acquire consumption capital by consuming, but also by interacting with other consumers. And since looking for like-minded counterparts creates costs, which, following Adler, decrease with the number of individuals consuming the same good, consumer choice is impacted by positive network like externalities. Because of these externalities, consumers end up patronizing the same producers who then become superstars.

Rosen´s model and Adler´s model each assume that consumers have complete transparency with regard to the talent of producers or the quality of the goods these producers offer. As has been argued in the first paper of this dissertation, an alternative framework is required to examine stardom in markets in which talent or quality is only partially revealed to consumers. A framework, which has simultaneously been presented by Bikhchandani, Hirshleifer and Welch (1992) and Banerjee (1992) as an explanation for the clustering of decisions in settings of imperfect information, is the theory of informational cascades. This theory sheds light on why individuals, who face a decision context that is marked by imperfect information with regard to the true payoff of their decision, rationally choose to ignore their private information and follow the decision of other individuals instead. As the first paper concludes, informational cascades are likely to contribute to superstar phenomena because imperfect information on the quality of goods induces consumers to engage in observational learning behavior, and include the decisions of fellow consumers in their decision rationale.

The following simple model, which the first paper has outlined in greater detail, illustrates how cascades lead to stardom. Assume a group of individuals who have to decide whether to consume art by artist X or art by artist Y. In this context, the consumption of art is restricted to the purchase of an artwork. One artist produces art of high quality which, when being consumed, results in a payoff of one. The other artist produces art of low quality, and the consumption of his art yields a payoff of zero. The unconditional probability of either artist being the producer of high quality art is $\frac{1}{2}$. Consumers decide sequentially in an exogenously defined order, which is known to all, which art to consume. The respective decisions are public information. Besides being able to observe the behavior of other individuals, each individual observes a private signal which is either s_x or s_y. The probability of observing either signal is conditional on which artist turns out to be the one with greater talent. If X has more talent, then the probability to observe an s_x is p with $0.5 < p < 1$ and the probability to observe an s_y is $1-p$. Conversely, if Y produces the art which is of high quality, then the probability to observe an s_y is p and to observe an s_x is $1-p$. All individuals are equally well informed about which artist is the more talented, and thus observe either signal with the same conditional probability. Individuals pick whatever art yields the higher expected payoff. An individual who is indifferent between choosing either artist flips a coin.

The first individual in the decision sequence chooses X if his signal is an s_x and goes for Y if he observes an s_y. When the first consumer has made his decision, remaining individuals can perfectly infer his signal from his behavior. If the second individual observes an s_x and has observed his predecessor consuming art made by X, he will choose to consume art by the same artist. If the two signals, one privately observed and one inferred from observational learning, are opposing, the second individual flips a coin and chooses either X or Y with equal probability. Assume that the first two individuals have decided to consume art by X and that the third individual is about to make his decision. Obviously, if he observes an s_x, he picks X as well. However, if his signal is an s_y he has to weigh his private information against the information which he has inferred by observing preceding decisions. He knows that the first individual has observed an s_x. The signal of the second individual is either s_x or s_y. However, it is more likely that he has observed an s_x as well. As a result, the third individual also opts for art by X despite his private signal. His behavior is therefore subject to an informational cascade which induces all remaining individuals of the decision sequence to follow the decision of the first two individuals. Even if X produces art of lower quality than Y, as soon as the pool of public information is informative enough to outweigh private information, a cascade leading all individuals to herd and buy art by artist X develops instantly and turns this artist into a superstar. Hence, because individuals have only imperfect information about the quality of goods and aim at limiting decision uncertainty by observing the decision of others, the behavior of these individuals is prone to informational cascades which can eventually result in superstar phenomena.

3 Related Literature

This paper is the first to empirically investigate the formation of superstars in their true sense based on informational cascades. However, the empirical relevance of cascade behavior as an explanation for general herding phenomena has already been examined. Zhou and Lai (2009) study herding and cascade behavior among investors based on data records from the Hong Kong stock exchange. The authors reveal that investors' behavior is influenced by informational cascades, and that investors tend to follow fashion leaders if information is distributed heterogeneously among decision makers. Informational cascades have also been investigated extensively in laboratory settings. Anderson and Holt (1997) not only show that cascade behavior develops in laboratory situations, but also that the probability for incorrect cascades is significant. Yet, experiments conducted by Huck and Oechssler (2000) suggest that fewer cascades occur than predicted by theory, and that individuals hardly ever apply Bayes' rule correctly. Kübler and Weizsäcker (2004) further substantiate these findings by showing that individuals tend to simply follow majority decisions and, at the same time, underestimate the probability that previous decisions makers are subject to cascade behavior. In the experimental setup of Çelen and Kariv (2004), the authors show that informational cascades do occur, but that players put excessive weight on their private information. Spiwoks, Bizer and Hein (2008) confirm the results of Huck and Oechssler. Their experiments show that participants rarely made rational decisions and instead applied simple rules of thumb. In conclusion, the empirical relevance of informational cascades as cause for herding behavior is still controversial.

Evidence for informational cascades in cultural sectors is scarce. De Vany and Walls (1996) link information dynamics of motion picture audiences to box office revenues. Their results indicate that weekly revenues are autocorrelated, and that recently experienced increases in revenue are likely to spark additional growth in the future. Kennedy (2002) studies phenomena of herding behavior in television programming. His analysis reveals that imitation strategies are common in program introductions of television networks, and that imitation is due to network executives participating in cascade-based as well as agency-related herd behavior. Rohner, Winestein and Frey (2006) empirically analyze the behavior of television spectators and how spectators choose between different program categories. The authors show that the combined program share of the four largest categories; movie, police, drama, and comedy has significantly increased within a particular time period while, in the same time period, the share of the four smallest categories; quiz, sports, cartoons and science fiction has significantly decreased. The authors conclude that these shifts in program shares are the result of spectators engaging in cascade behavior. However, the authors do not provide any evidence that concentration in television programs is due to informational cascades and not related to other herding mechanisms.[3]

Numerous empirical studies examine the relevance of Rosen's superstar model as well as Adler's framework in different economic fields such as performing arts, sports and even culinary fields. A detailed overview of these studies is provided in the first paper of this dissertation. In conclusion, the empirical examinations of stardom have produced contradictory results which do not provide a consistent answer to how superstar phenomena develop. Whereas Hamlen (1991) fails to find evidence for Rosen-style stardom in pop music, results presented by Franck and Nüesch (2010), who analyze the market for soccer players, reveal that talent does have a major influence on superstar phenomena. The testing of the model proposed by Adler has yielded contrasting results as well. The empirical analysis of music record sales by Chung and Cox (1994) support Adler's view, which is that stardom does not require superior talent. The study of Ehrmann, Meiseberg and Ritz (2009), who analyze stardom among chefs, fails to find evidence for either Rosen's or Adler's view.

As the first paper of this dissertation points out, the contradicting results which empirical examinations of superstar phenomena have yielded so

[3]In fact, concentration might not even be a result of herding phenomena. For instance, the share of the four largest categories might have increased because programs in these categories are simply more profitable.

far underline the relevance of alternative explanations for stardom, especially in areas where talent and quality are marked by in-transparency. The analyses presented here contributes to both strands of empirical literature. First, they provide further information on the empirical relevance of informational cascades and indicate whether cascade behavior exists in the realms of arts and culture. Second, the analyses empirically substantiate the proposition that the concept of informational cascades provides a useful theoretical framework for explaining stardom in markets in which consumers face imperfect information.

4 Hypotheses

The first paper of this dissertation has already pointed out that markets in which informational cascades as theoretical fundament for the explanation of stardom are expected to be particularly relevant are the markets for fine art. Cascades are expected to contribute significantly to the emergence of superstars in these markets because of the exceptional valuation uncertainty which consumers face when buying art, and because of how the value of art is determined. There are no valuation mechanisms that are based on a simple demand-supply perspective or on the physical characteristics of an oeuvre. Instead, the value of art is socially constructed based on a sequential process interlinking the different players who engage in art market activities such as critics, collectors, or curators. In art markets, as Velthuis explains, "prices do not reflect a simple composite of individual evaluations, but rather complex, collective evaluations, which are subject to intra-group influences." (Velthuis (2003), 190). Because the quality of fine art, i.e. its cultural or artistic quality, is determined based on social interaction, because of the sequential nature of the art valuation process and because of the resulting valuation uncertainty which consumers face, the first paper of this dissertation concludes that informational cascades contribute significantly to superstar phenomena in markets in which fine art is traded. By taking the consumption decision of others into account, especially those made by reputable individuals or institutions that are perceived to have superior knowledge, consumers try to gain additional decision relevant information to limit the risk of allocating their resources to artists of inferior talent, and buying art which is of no sustainable value. For example, before a consumer decides to purchase a plastic by Giacometti it is likely that he analyzes who else has been buying works by this artist. Therefore, Matisse, Picasso, Klee and the like have not necessarily become superstars because of their superior talent or the exceptional quality of their works, but because informational cascades convinced the art consuming community to buy their oeuvres and to turn once unknown artists into famous exponents of their guild.

Before examining the role of informational cascades in the creation of artistic superstars, one needs to analyze whether superstar phenomena actually exist in the markets for fine art. Rosen defines superstars as individuals who "earn enormous amounts of money and seem to dominate the fields in which they engage" (Rosen (1981), 845). Hence, according to Rosen, stardom results in a skewed distribution of earnings as well as a concentration of output on just a few producers. There is no reliable systematic data on the earnings of artists. However, the individual auction performance of an artist, i.e. the annual auction sales generated by his works, provides a suitable proxy for his income. As Franck and Nüesch (2010, 10) point out: "The earnings of painters, authors or athletes in individual sports are directly determined by the market potential of their services." Even though an artist does not usually directly sell his works on the auction market, auction prices do have a strong influence on the prices which he is able to get when selling his works within the dealer market. Therefore, this paper uses auction volume as a proxy for the earnings of an artist. Auction sales are also a suitable measure for capturing whether output in art markets is concentrated among just a few producers. Therefore, since art markets are expected to be subject to superstar phenomena, this paper proposes that

> **Hypothesis 1:** *The distribution of auction volume in art markets is significantly skewed.*

Given the empirical relevance of stardom in art markets, it is expected that informational cascades impacting consumer behavior contribute significantly to the emergence of stardom in these markets. If the consumption of art is specifically defined as the purchase of art, consumer behavior can be studied based on sales activities in the three market segments in which art is traded: In the primary and secondary market, where art works are sold through dealers and galleries, and in the tertiary market, i.e. the auction market. Since only auctions offer reliable and transparent data on the sales performance of individual artists, this paper examines consumer choice based on auction results and therefore expects that

> **Hypothesis 2:** *Consumer choice is strongly affected by artists' historical auction performance.*

Valuation uncertainty is especially prominent in markets for contemporary art. As Jeffri (2005, 130) argues, compared to appraising works by artists who have already died, predicting the long term value of a living artist is even more difficult. According to Plattner (1998, 482), consumers in this particular market segment "often have no idea of the value of what they buy". The value of contemporary art is more difficult to determine because contemporary art is still in the process of social recognition and has not yet been "filtered" to the same extent as art of preceding art periods. In cascade theory, a high level of decision uncertainty is captured by a low precision of signals which decision makers privately receive. This seems controversial to the thesis of this paper since, as Bikhchandani, Hirshleifer and Welch (1992, 998) show, low signal precision delays the formation of informational cascades. But as the first paper of this dissertation has already pointed out, art markets are not only subject to high decision uncertainty, but also to information asymmetries which result in high influential power of a limited number of art experts. The presence of such experts with superior information, termed "fashion leaders" in cascade literature, accelerates the formation of informational cascades because the informational advantage of fashion leaders induces individuals to quickly copy their behavior. Thus, the higher the level of decision uncertainty the stronger the influence of informational cascades on individual decision making. This is in line with Mandel (2009, 2) who points out that fad behavior in art markets is expected to be particularly pronounced "for living artists for whom the status and legacy of their works are uncertain". This paper therefore expects that

> **Hypothesis 3:** *Historical auction performance has a stronger impact on consumer choice in markets for contemporary art than in other art markets.*

Rosen's explanation of stardom is based on advances in production technology enabling joint consumption as well as differences in talent. At first glance, the first argument seems to be only of minor relevance when applying Rosen's framework to art markets. The value of an artwork is strongly tied to the original work, and fine art cannot be as easily reproduced as music or lyrics. For example, Rembrandt's "The Man with the Golden Helmet" experienced sudden devaluation when experts announced that it had been created by one of the master's assistants and not by the master himself. Therefore, the essence of buying art is buying original art. The theoretical concept of joint consumption could be considered more relevant if the definition of art consumption is further extended. For example, for Adler consuming art translates into: looking at it, apprehending it, and discussing it with other like-minded individuals (Adler (1985), 209). In this case, developments in technologies enabling the reproduction of art and the general distribution of information on art are in fact relevant. However, even if joint consumption is applicable to markets for fine art, the empirical relevance of Rosen's stardom explanation is more reliably tested based on the second argument brought forward by the author: the hierarchy and the imperfect substitutability of talent or quality. Empirical evidence indicating that the artistic quality of the works an artist produces has a weaker influence on consumers' choice than other determinants would support the thesis that Rosen's model is of limited applicability with respect to markets for fine art, and presumably to any market in which the quality of goods is characterized by imperfect information. This paper therefore proposes that

> **Hypothesis 4:** *Relative to historical auction performance, artistic quality has a weaker influence on individuals' decision which art to consume.*

In contrast to Rosen, the superstar model presented by Adler does not require heterogeneous distribution of talent. By accounting for positive payoff externalities, stardom can as well emerge in a setting where artists have equal talent. Adler's theory implies that the demand for the works of a particular artist increases with the number of consumers being interested in that artist, i.e. the artist's popularity. But payoff externalities are not only relevant due to how consumers acquire consumption capital. In certain markets, in which superstar phenomena can generally be observed, the consumption of goods is affected by bandwagon effects. As the first paper of this dissertation has pointed out, due to these effects the popularity of a producer directly impacts individuals' payoff when consuming his goods. This extra payoff is linked to the fact that individuals prefer consuming goods that are considered trendy, which, as the first paper of this dissertation has pointed out, also applies to artistic goods. Hence, this paper assumes that positive payoff externalities contribute to the formation of superstars in art markets and therefore expects that

> **Hypothesis 5:** *The popularity of artists significantly impacts consumer choice.*

The empirical data set which is used to test the hypotheses outlined above is described in the following section of the paper.

5 Empirical Analyses

5.1 Description of the Data Set

The empirical examination of superstar phenomena in art markets is based on data provided by Artfacts.Net^{TM}, a private company referred to as "Artfacts" hereafter. Artfacts offers information on artists and art market activities that has been collected from artists, galleries, auction houses, museums and other public art institutions. Besides general information on artists and their works, Artfacts provides analytical data which are divided into two categories: Auction data and exhibition data. The auction category contains information on the auction performance of an artist such as price estimates, average prices, number of lots sold and number of lots bought in, i.e. lots that were auctioned but not sold, either because no bid was made or because bids did not reach the reserve price. In the exhibition category, Artfacts provides information about the global representation of an artist in gallery shows, museum exhibitions and art fairs. Since 1998, Artfacts evaluates individual artists based on how much attention these artists have received from galleries, public art institutions, fairs and festivals. Artfacts quantifies the attention an artist has received by the art community based on a point system. In this system, each artist receives a certain number of exhibition points for each presentation of his works. How many exhibition points an artist receives depends not only on how many times this artist has been exhibited, but also on the quality of exhibitions. Artfacts publishes a ranking that lists artist according to the number of accumulated exhibition points.

In order to investigate cascade behavior in markets for art and test the hypotheses presented in section (4), this paper investigates three different artist

Table 1: Definition of samples

Sample		*Sample description*	*Sample size*
A	Leading artists	Artists ranked 1 to 400 in the Artfacts ranking	400
B	Emerging artists	Artists ranked 401 to 800 in the Artfacts ranking	400
C	Contemporary artists	Top 450 artists of the Artfacts ranking that are still living	450

samples: Sample A, labeled "leading artists", consists of the 400 artists that were ranked highest in the exhibition point based ranking published by Artfacts.[4] The second group of artists, sample B, consists of the 400 artists from position 401 to 800 in the Artfacts ranking. This sample is labeled "emerging artists", knowing that this label is somehow subjective and that artists of this group already belong to the league of successful artists. Sample C, the "contemporary artists", includes the leading 450 contemporary artists in the Artfacts ranking. Given the lack of incontestable characteristics defining contemporary art, this paper defines contemporary art very narrowly as art that has been been produced by artists who are still living. In total, auction and exhibition data of 800 artists have been collected from Artfacts. Table (1) summarizes the definition of samples.

The information on each artist, which has been retrieved from the Artfacts database, consists of: the artist's exhibition points, the auction sales generated through his works, the number of lots sold, the lots' average selling price, and finally the number of lots that were bought in. The data were collected on an annual basis, and cover the years 2004 to 2009. In order to be able to assign every artist to the respective sample outlined above, the information collected from Artfacts also consisted of the artist's year of birth as well as, if applicable, the year of his death.

[4]The artist ranking is continuously updated by Artfacts based on current gallery shows, fairs, museum exhibitions etc. The list of artists that has been used for the analyses presented in this paper has been retrieved on October 11, 2010.

5.2 Econometric Methodology

Similar to Duan, Gu and Whinston (2009) and their analysis of how informational cascades impact software downloads, this paper analyzes cascade behavior in art markets based on a multinomial logit (MNL) market-share model. Consequently, instead of analyzing each individual purchase decision, consumer choice is examined collectively based on the market share of individual artists.[5] Following the least squares estimation approach of Nakanishi and Cooper (1974), the model is specified as follows:

$$lg\left(\Pi_{it}\right) = \left(\alpha_i - \overline{\alpha}\right) + \sum_{k=1}^{K} \beta_k \left(X_{ikt} - \overline{X}_{kt}\right) + \left(\epsilon_{it} - \overline{\epsilon}_t\right) \tag{1}$$

Π_{it} captures the choice of art consumers and is based on the relative demand for artist i at time t. Relative demand is defined as

$$\Pi_{it} = \frac{S_{it}}{\widetilde{S}_t} = \frac{\frac{V_{it}}{V_t}}{\sqrt[n]{\prod_{j=1}^{n} \frac{V_{jt}}{V_t}}} \tag{2}$$

As shown by this equation, relative demand Π_{it} is measured based on the artist's auction share S_{it}, defined as the artist's auction volume V_{it} divided by total auction volume V_t generated by all n artists at time t, relative to the geometric mean of individual auction shares across all artists denoted by $\widetilde{S}_t$. The auction volume of an artist is determined based on the annual auction sales generated by his works in one year. Total auction volume is defined as the sum of individual auction volumes generated by those artists that are included in the respective samples which have been specified in section (5.1). Consequently, each sample is treated as a separate market, and within each market individuals have no ex ante preferences for any specific artist or type of art. This implies, for example, that an individual choosing between works of art which have been produced by the 450 artists included in the group of contemporary artists is equally interested in the sculptures of Takashi Murakami and the photographies by Andreas Gursky. The implications of this assumption are further discussed in section (6). Parameter α_i is the intrinsic value of the artist, X_{ikt} is the value of the k^{th} explanatory variable and ϵ_{it} the error term of the model. $\overline{\alpha}$, $\overline{X}_{kt}$ and $\overline{\epsilon}_t$ are the respective arithmetic means of

[5]Similar models have for example been applied to measure brand purchase probabilities or to analyze the effectiveness of advertising campaigns (Nakanishi and Cooper (1974), 303).

the underlying variables. As shown by Duan, Gu and Whinston, equation (1) can be reformulated to

$$lg\left(\Pi_{it}\right) = \alpha_i + \alpha_t + \sum_{j=1}^{J} \beta_j \left(X_{ijt} - \overline{X}_{jt}\right) + \epsilon_{it} \tag{3}$$

In this model, α_i captures the artist-specific fixed affects to control for the intrinsic characteristics of each artist which influence demand. Similarly, α_t captures the intrinsic time-specific characteristics of the market.

Table 2: Description of variables

Dependent variable	$LGDEMAND_t$	Logarithm of relative demand for works by artist i at time t
Independent variables	$QUALITY_{t-1}$	Position of artist i in the cumulated exhibition points ranking at time $t-1$
	$POPULARITY_t$	Position of artist i in the annual exhibition points ranking at time t
	$AUCTION_{t-1}$	Position of artist i in the auction ranking at time $t-1$
	$DEAD_t$	Dummy variable indicating whether artist i was dead at time t
	$AGESQ_t$	Artist's i squared age at time t measured in years

Equation (3) is estimated based on the panel data that have been collected from the Artfacts database. The data consist of annual observations of each artist's auction performance as well as exhibition performance. The dependent variable is the logarithm of relative demand for works by artist i at time t ($LGDEMAND_t$).

To test the influence of artistic quality on demand (hypothesis (4)), the variable $QUALITY$ is included in the model. This variable reflects the position of the respective artist in the exhibition ranking which lists all artists according to their exhibition points accumulated by the end of time t. As Jeffri (2005, 129) as well as Chong (2005, 86) point out, the public representation of an artist has a significant influence on the validation of his art and is a substantial element in the determination of artistic quality. Hence, the number of exhibition points an artist collects over the course of his career appropriately captures the artistic quality of his works. In the exhibition ranking, the artist with the highest number of points is listed on position one. If demand depends on artistic quality, it is therefore expected that the impact of $QUALITY$ is negative, i.e. a lower ranking position leads to an increase in demand. To reflect the level of information available to consumers at time t, the quality of an artist is based on his position in the ranking of the preceding year ($QUALITY_{t-1}$).

To assess whether consumer behavior in art markets depends on positive payoff externalities (hypothesis (5)), either because of how consumers acquire consumption capital as proposed by Adler's superstar theory or because the popularity of an artist directly increases consumers' payoffs, a variable capturing an artist's current popularity is also included in the estimation model. Popularity is measured based on the exhibition points an artist receives in one particular year. The more points an artist is able to collect, the higher the number and quality of exhibitions and thus the bigger the group of individuals who are familiar with this artist. If payoff externalities prove to be relevant in the markets for art, it is expected that increasing popularity results in higher demand. Similar to $QUALITY$ which is measured based on the artist's position in the exhibition ranking, the coefficient of $POPULARITY$ is measured based on a ranking. In this case, artists are ranked according to exhibition points collected in one particular year instead of accumulated exhibition points. The explanatory variable included in the model is $POPULARITY_t$ because, following Adler's superstar explanation, consumer behavior is likely to be influenced by the attention that an artist currently receives (Adler (1985), 208).

Analyzing the influence of informational cascades on the behavior of art consumers and testing hypothesis (2) is based on a two-step approach. The first step consists of testing whether art consumers engage in herding behavior. In the second step, the relevance of informational cascades as a trigger for herding behavior is investigated.

In order to test the relevance of herding phenomena, the variable $AUCTION$ is included in the estimation model as an additional explanatory variable. It captures the artist's position in the auction ranking, which ranks artists according to their annual sales volume. Again, to reflect the most recent information available to consumers, the variable captures the artist's auction performance in the year prior to t ($AUCTION_{t-1}$).

The second step, testing whether herding phenomena among art consumers are caused by informational cascades, is more complex. According to Welch (2000, 371), discriminating between alternative herding mechanisms based on empirical investigations requires access to micro information in order to get insights into individual decision making processes. However, this sort of information is rarely available, which explains why laboratory experiments are so prominent in cascade research. The majority of empirical investigations of informational cascades have been conducted in financial markets. But in contrast to financial markets, art market activities are characterized by lower liquidity and transparency. Therefore, this paper studies the relevance of informational cascades by analyzing phenomena that are symptomatic for cascade behavior.

Based on Bikhchandani, Hirshleifer and Welch (1992), the three key symptoms of herding that has been caused by informational cascades may be summarized as follows: First, herding that has been caused by informational cascades tends to be fragile. Second, individuals ignore their private information when imitating the behavior of others. Third, the formation of herding behavior increases when decision uncertainty is significant, and when information is heterogeneously distributed among individuals. As the first paper of this dissertation has already pointed out, the first argument is of limited applicability with respect to art markets because, in contrast to other decision contexts, cascade behavior in art markets tends to be self-reinforcing. The extended cascade model which has been presented in the first paper shows that increased stability of cascades can be explained by combining informational and payoff externalities, which are expected to play a significant role in markets for fine art. Whether art consumers ignore their private information when following the herd, the key symptom of cascade behavior, is concluded based on comparing the fixed estimation results of quality and auction performance. If an artist's historical auction performance proves to have a significantly stronger effect on consumer choice than his artistic quality, then it is likely that individuals discard private information, i.e. the quality of an artist relative to other artists, when joining the herd. This is similar to the approach of Duan, Gu and Whinston (2009). The third aspect of cascade behavior is analyzed by comparing the regression results of sample A with the respective results of sample B and sample C. Herding is likely to have been caused by informational cascades if the effect of past auction performance on consumer choice is stronger in markets for contemporary art and with regard to emerging artists since consuming art by artists of these two groups is marked by higher decision uncertainty.

Two additional variables are included in the estimation model to capture other relevant factors impacting demand. The first control variable is $DEAD_t$. This dummy variable is one if artist i was dead at time t and zero otherwise. As an empirical study by Maddison and Pedersen (2008) shows, whether an artist is dead or still living has an impact on the prices of his paintings. The second control variable in the estimation model, $AGESQ_t$, captures the squared age of an artist at time t. This variable is included in the model to capture age effects on demand. As Maddison and Pedersen note, the age of an artist is an indicator for his conditional life expectancy and thus captures anticipated conditions of supply (Maddison and Pedersen (2008), 1792).[6]

5.3 Descriptive Statistics

The percentiles of the distribution of artists' individual auction volume provide a first indication for the skewed distribution of auction volume in art markets, and the unequal allocation of earnings among artists (hypothesis (1)).

As table (3) shows, an artist belonging to the top ten percent of his class generated more than 27 times the auction volume in 2009 of an artist around the median of the distribution and more than 970 times the auction volume of an artist located in the bottom ten percent of the distribution. These results indicate that few artists yield extraordinary income relative to the earnings of fellow artists.

Figure (1) presents density estimates for the distribution of individual auction volumes in the years 2004 to 2009. The lack of symmetry in the distribution and its strong skewness to the right further reveal that a small number of artists yield extraordinary earnings while earnings of the great majority of artists are significantly lower.

The Gini-coefficients of the auction volume distribution in the respective years presented in figure (2) show that skewness has constantly remained on a

[6]Other papers, which empirically investigate stardom phenomena, have also included age variables in their models. In these models, age is applied as a proxy for professional experience or career duration, e.g. of soccer players (Lucifora and Simmons (2003), 42). However, as Beckert and Rössel (2004, 44) show, career duration seems to be of minor relevance in the auction market for fine art.

Table 3: Distribution of auction volume

This table provides an overview of the percentiles of the distribution of artists' individual auction volume in the years 2004–2009. The results are based on the auction data of the 800 artists that are included in the three samples described in section (5.1). Auction volume is given in million Euros.

Year	*Percentiles*				
	0.10	0.25	0.50	0.75	0.90
2004	6,126	41,659	232,222	1,378,627	6,117,604
2005	11,145	50,977	406,179	1,659,822	6,972,738
2006	8,400	68,588	409,862	2,466,736	11,410,241
2007	8,347	62,963	581,111	3,791,724	14,658,228
2008	8,639	48,827	369,909	2,012,192	11,032,860
2009	6,501	35,094	228,860	1,144,416	6,364,851

high level over the last years, and confirms the strong concentration of earning among artists.[7] In the years 2004 to 2009, the Gini-coefficient has never dropped below 0.82, indicating a high degree of inequality in the distribution. In conclusion, these findings indicate that phenomena of stardom are of significant relevance in the markets for art.

The performance of selected artists in the auction and exhibition ranking presented in table (4), provides a first indication for cascade-based herding. These examples show how well an artist performs in terms of auction results, which do not necessarily correspond to the evaluation of his artistic quality.

5.4 Regression Results

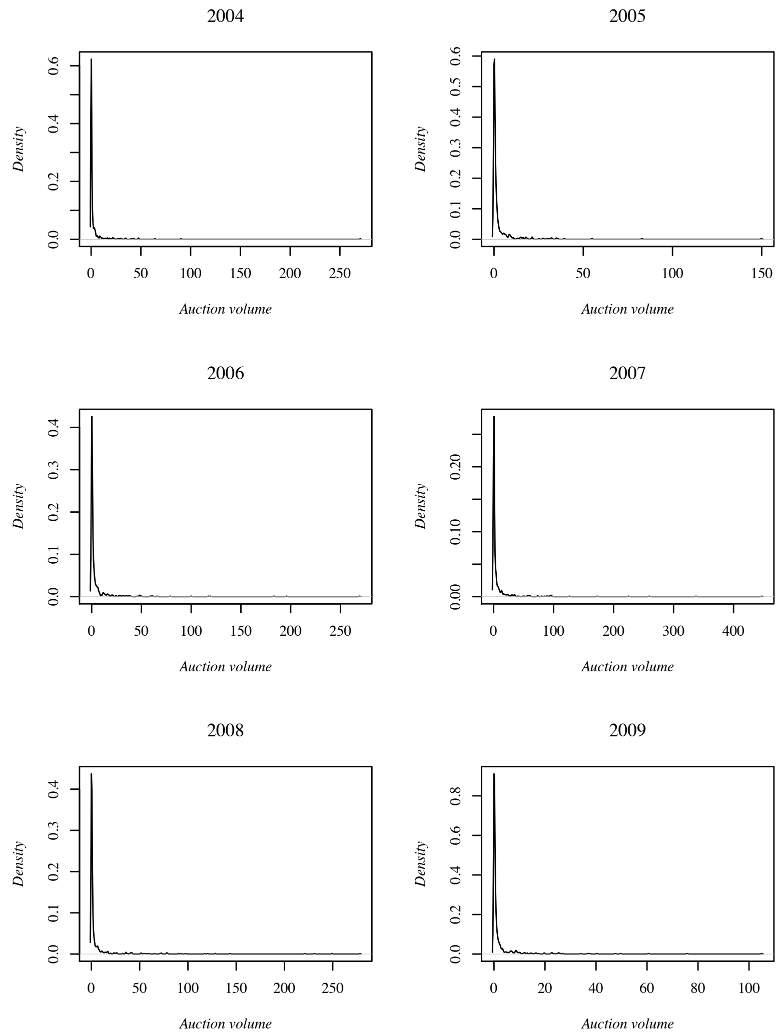
The panel data described in section (5.1) is used to estimate the regression model specified in equation (3). Ordinary Least Squares (OLS) regression models are used to determine the estimated effects of the explanatory variables on the dependent variable $LGDEMAND_t$ with respect to each of the three samples. An overview of the estimation results of these OLS regressions is provided in tables (5) and (6).

Table (5) shows that a significant coefficient for $QUALITY_{t-1}$ is only found

[7]The Gini-coefficient measures the equality of a distribution and is commonly applied to assess the distribution of earnings. The coefficient ranges from 0 to 1, with 0 indicating perfect equality and 1 indicating perfect inequality.

Figure 1: Density estimation of auction volume

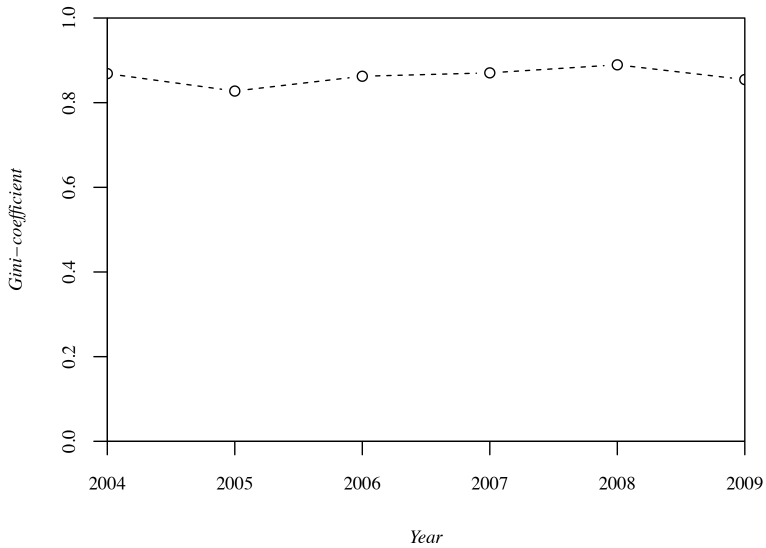
This figure shows kernel density estimation results based on the distribution of individual auction volume of the 800 artists in the years 2004–2009. Auction volume is given in million Euros.



when estimating the model based on panel data from sample A, which includes the leading 400 artists of the Artfacts ranking (significant at the 10 percent level). With regard to the second and the third sample, the emerging and the contemporary artists, differences in quality between artists seem to have no significant impact on consumer choice. These empirical findings indicate that Rosen's explanation of stardom does not consistently apply to all art markets and support hypothesis (4). Since the quality of art that has been

Figure 2: Gini-coefficients of auction volume

This figure illustrates the concentration of auction volume in the years 2004-2009 based on the Gini-coefficient. A coefficient of 0 signals perfectly equal distribution while a coefficient close to 1 indicates highly unequal distribution.



produced by emerging as well as contemporary artists, and thus the true value of their works is highly uncertain, consumers seem to be less interested in differentiating between high quality and low quality art when consuming art that has been produced by artists belonging to either of the two groups. In conclusion, superstar phenomena in these two market segments are not likely to result from differences in talent.

The estimated coefficients for $POPULARITY_t$, which captures the attention an artist currently receives, reveal that this variable seems to play a more relevant role in consumer choice than artistic quality. The coefficient is significant at the 5 percent level for the top 400 artists as well as for the contemporary artists. These results show that consumer behavior does in fact depend on how many consumers are familiar with an artist, but apparently not to a significant extent in all art markets. These findings highlight the relevance of positive payoff externalities with respect to the formation of stardom, either due to how consumers acquire art specific knowledge or due to bandwagon effects impacting consumers' payoffs.

In contrast to quality and popularity, the findings with regard to the herding variable show a clear and consistent picture. The estimated coefficients

Table 4: Performance of selected artists

This table presents performance data of selected artists with respect to position changes in the auction as well as exhibition ranking from 2008 to 2009.

Artist	*Auction ranking*			*Exhibition ranking*		
	Rank 2008	*Rank 2009*	*Delta*	*Rank 2008*	*Rank 2009*	*Delta*
E. L. Kirchner	49	23	–26	37	39	+2
Y. Kusama	133	56	–77	108	113	+5
L. Tuymans	161	134	–27	110	114	+19
P. Cézanne	32	73	+41	78	70	–8
C. Twombly	35	48	+13	121	98	–23
A. R. Penck	136	156	+20	143	127	–16

for $AUCTION_{t-1}$ are significant at the 1 percent level for all three samples. These estimation results indicate that the historical auction performance of artists has a strong influence on consumer behavior. These findings support hypothesis (2). The results also show that estimated coefficients for the herding variable are significantly higher than the coefficients for quality or popularity. Since the coefficient of the contemporary sample is higher relative to the other two samples, the results indicate that herding has a stronger impact on the behavior of consumers vis à vis contemporary art which is in line with hypothesis (3). Following the estimation results, a contemporary artist experiences more than a 2 percent increase in relative demand for each advance in auction ranking, whereas moving up the popularity ranking by one position results in an increase of around 0.01 percent.

The relevance of informational cascades is tested by comparing the fixed effects estimation results for the quality variable and the herding variable. The differences between estimated coefficients indicate that informational cascades are a significant cause for herding behavior. With regard to the leading artists, an artist that is able to climb the auction ranking by one position is able to increase demand by an estimated 1.26 percent in the following year. On the other hand, an advance of one position in the exhibition ranking increases demand by only 0.07 percent. These results indicate that the signal conveyed through the action of other consumers dominates private information on the quality of an artist, which provides a strong indication for the presence of informational cascades. Based on the results of the contemporary artist

Table 5: Regression results (I)

This table reports the fixed effects estimation results based on panel data of sample A (leading artists), B (emerging artists) and C (contemporary artists). Coefficients marked with ***, **, and * are significant at the 1, 5, and 10 percent level respectively.

Explanatory variable	*Sample*	*Estimate*	*Standard error*	*t-value*	*Significance*
Constant	A	3.7763	0.1241	30.4212	***
	B	3.2594	0.2628	12.4015	***
	C	3.5753	0.1210	29.5438	***
$QUALITY_{t-1}$	A	-0.0007	0.0004	-1.8684	*
	B	0.0005	0.0003	1.4526	
	C	-0.0001	0.0004	-0.3500	
$POPULARITY_t$	A	-0.0005	0.0002	-2.2378	**
	B	0.0002	0.0002	0.6423	
	C	-0.0009	0.0004	-2.1936	**
$AUCTION_{t-1}$	A	-0.0126	0.0003	-43.1557	***
	B	-0.0124	0.0003	-40.6135	***
	C	-0.0215	0.0004	-48.0745	***
$DEAD_t$	A	0.4114	0.0902	4.5626	***
	B	0.3306	0.0935	3.5358	***
	C	-	-	-	-
$AGESQ_t$	A	0.0000	0.0000	1.9204	*
	B	-0.0000	0.0000	-2.2032	**
	C	0.0000	0.0000	0.5148	

sample, where quality has no significant influence on consumer behavior, the strong effect of past auction performance is even more apparent. The results reveal that consumers of art who face a high degree of uncertainty with regard to its quality are even more inclined towards herding. This outcome further substantiates the hypothesis that herding behavior is caused by informational cascades.

The results for the two control variables show that, in line with the findings of other empirical analyses, the death of an artist has a positive effect on demand. The estimated coefficient is significant at the 1 percent level for the leading artists sample as well as the emerging artists sample. Evidently, the variable has not been included in the estimation model for the contemporary artists. However, the age of an artist, as proxy for anticipated supply conditions, has no major effect on demand. Estimated coefficients are either not

Table 6: Regression results (II)

This table presents the results of the regression analysis based on the respective panel data of sample A (leading artists), B (emerging artists) and C (contemporary artists).

	Sample		
	A	*B*	*C*
Number of observations	1,592	1,200	1,465
R^2	0.7539	0.7068	0.6959
Adjusted R^2	0.7531	0.7056	0.6950
F-statistic	972	576	835
p-value	<0.001	<0.001	<0.001
Durbin-Watson statistic	2.2068	2.1592	2.2286
Maximum variance inflation factor (VIF)	1.6435	1.4119	2.0798

significant or very low.

Table 7: Correlation coefficients

This table presents the pairwise Pearson correlation coefficients between the respective explanatory variables based on data of sample A. Coefficients above 0.5 are underlined.

		I	*II*	*III*	*IV*	*V*
I	$QUALITY_{t-1}$	1.00	-	-	-	-
II	$POPULARITY_t$	$\underline{0.51}$	1.00	-	-	-
III	$AUCTION_{t-1}$	0.29	0.26	1.00	-	-
IV	$DEAD_t$	-0.08	-0.12	-0.48	1.00	-
V	$AGESQ_t$	-0.20	-0.20	-0.44	0.42	1.00

To assess whether the estimation model is subject to issues of multicollinearity, pairwise correlation coefficients have been determined and are reported in table (7). The table shows that a high correlation coefficient above 0.5 is only found for the variable capturing the talent of an artist ($QUALITY_t$), and the variable which is included in the model to measure an artist's popularity ($POPULARITY_t$). However, the maximum variance inflation factors (VIF), which are reported in table (6), are significantly below 10 for all explanatory variables and all samples. This critical value is generally applied as an indicator for the presence of inefficient estimation results due to multicollinearity. To further examine potential issues of multicollinearity, the stability of the estimated coefficients was tested by dropping independent variables and running single regression. These trial runs did not produce any extraordinary changes with regard to the estimation of coefficients and their significance. A second consideration refers to potential inaccuracies of standard errors due to heteroskedasticity in the error terms. To control for heteroskedasticity, standard errors reported in table (5) are robust standard errors that are based on heteroskedasticity consistent covariances. To control for autocorrelation, residuals where examined based on Durbin-Watson tests. The Durbin-Watson statistics for the respective samples are reported in table (6), and indicate that the OLS results presented here do not suffer from serious autocorrelation. The assessment of the normal distribution of disturbance terms did not reveal any serious issues either.

In conclusion, the fixed effects OLS estimation results show that the behavior of art consumers is significantly affected by herding behavior. The estimated coefficients indicate that herding is particularly relevant in the markets for contemporary art, and that the quality of an artist has either no significant or only a weak influence on consumer choice. These findings are in line with the predictions of informational cascade theory, thereby pointing to the relevance of cascade behavior with regard to the emergence of superstars in fine art markets. Positive payoff externalities also seem to have a significant effect on the decision rationale of art consumers. These results indicate that such externalities do play a relevant role in the creation of superstars, and substantiate the point made in the first paper of this dissertation: Stardom is often the result of a combination of informational and payoff externalities. All findings confirm the five hypothesis which have been stated in section (4).

6 Limitations

The empirical results presented in this paper provide evidence for herding-based stardom and indicate that herding is caused by informational cascades. The identification of cascades is based on the symptomatic characteristics of cascade behavior: An individual ignores his private information when imitating the behavior of other individuals, and high decision uncertainty combined with heterogeneous information accelerates the formation of cascades. Since the statistical findings of this paper are based on collective consumer reasoning, this paper only provides an indication for the relevance of cascades as cause for herding. Hence, despite the evidence presented here, it is possible that herding in the markets for fine art might have been caused by alternative herding mechanisms or that cascades contribute only partially to imitative behavior. The estimation results already indicate that payoff externalities impact consumer behavior. Herds might also have been triggered by a simple preference for conformity or by sanctions upon deviants. Or, consumers do not herd at all and simply react idiosyncratically to information which has not been captured by the estimation model.

Informational cascade theory assumes that individuals behave perfectly rational. However, as has already been pointed out in section (3), experimental analyses of cascade behavior have nourished doubts that individuals behave perfectly rational when observing other individuals' behavior and correctly process all available information based on Bayesian inference. The fact that emotional drivers are highly relevant with regard to the valuation and demand for fine art, as stated for instance by Atukeren and Seckin (2007, 1), further limits the applicability of the assumption that individuals behave perfectly rational.

The model outlined in this paper not only assumes that all art consumers are aware of the quality of an artist, but also that artistic quality is solely measured based on the representation of that artist. Hence, other sources of information which shed light on the question as to whether a certain artist produces "good" or "bad" art, such as opinions published by critics, are not reflected in the model. Furthermore, information on art sales is based on auction activities only. Other sales platforms such as galleries or art fairs are not considered by this analysis.

The model assumes that consumers have homogeneous preferences and are indifferent with regard to the artists which have been chosen as basis for this analysis. However, as has already been stated in the beginning of the paper, the art market consists of a great number of different market segments or smaller art markets. Some individuals only participate in markets where art from the Middle East is traded, while some are interested in sculptures or video installations. The indicator of demand as it has been employed in this analysis therefore simplifies consumer preferences, and assumes that different works of art are perfectly substitutable.

7 Conclusion

This paper has provided empirical evidence that herding behavior among consumers in markets for fine art is significant. The finding that the historical auction performance of an artist has a more significant impact on his current success than the quality of his works indicates that herding is likely to have been caused by informational cascades. The fact that these results especially apply to less established artists as well as contemporary artists further substantiate the relevance of cascade behavior as a trigger for herding phenomena. These results are in line with the predictions of the first paper of this dissertation, and provide a strong indication that cascades contribute substantially to the formation of superstars in markets for fine art.

The assessment of cascade behavior in art markets has also provided further insights into the relevance of positive payoff externalities in the formation of superstars. The auction performance of contemporary artists has especially shown to be significantly affected by their current popularity. This finding might either be interpreted as proof for Adler's superstar theory that stardom is closely linked to how consumers acquire consumption capital, or as proof that consumers favor popular artists since consuming their goods results in higher payoffs due to bandwagon effects.

The empirical relevance of informational externalities as well as payoff externalities in a decision context which is subject to herding behavior, highlights what has already been pointed out in the first paper as well as in previous research in this field. As soon as more than one herding mechanism contributes to the formation of imitative behavior, it becomes difficult to clearly identify the dominant trigger leading to such phenomena.

Consequently, the further validation of these findings requires analyses of consumer behavior in a controlled environment which permits the collection of information on individual decision making. The results of a laboratory experiment presented by Salganik, Dodds and Watts (2006) show the strong influence of cascades on the consumption of music. In their experiment, participants chose which songs to download. The information participants observed was information on the artist as well as other individuals' downloading behavior. A similar experiment in which participants choose between different artists based on information on the artists' quality as well as other participants' choice would permit a more reliable determination of which mechanisms cause herding, and could yield insights that further substantiate the findings presented in this paper. Such an experiment could also include positive payoff externalities in order to discriminate between information-based and payoff-based herding and examine the interrelation between these two sources of behavioral uniformity.

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Superstars and Informational Cascades: Cascade Seeding as Stairway to Stardom

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Abstract: This paper presents an informational cascade model with an influencer who deliberately seeds cascade behavior. The model shows that whether cascade seeding pays off and whether it constitutes an effective access to stardom depends on the length of the decision sequence, on how well individuals are informed and whether the decision, which the influencer wants individuals to make, is favorable or unfavorable. This paper also shows that if two influencers compete for stardom, these influencers engage in an "incentive competition" which leaves both of them empty handed.

Keywords: Superstars, herding, informational cascades

JEL Classifications: C73, D70, D82, D83

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1 Introduction

Why do people prefer to enter an already crowded restaurant instead of going into the deserted place across the street, and why do bestseller lists have such a significant impact on book sales? Herding is an omnipresent phenomenon, and the reasons why individuals who are free to do what they want eventually do what others do are manifold. For instance, behavioral uniformity simply emerges if individuals who face the same decision situation have identical payoff functions, preferences, as well as information, thereby making the same choice. Herding can also form because of payoff externalities or preference interdependencies. Or, individuals join the bandwagon because they face a decision context marked by imperfect information, and in order to limit decision uncertainty they rationally follow the behavior of others. Such herding phenomena are labeled informational cascades, and have first been explored by Bikhchandani, Hirshleifer and Welch (1992) and Banerjee (1992). The theory of informational cascades explains why individuals who observe other individuals' behavior make decisions that might go against their own private beliefs.

Much has been written about how decision ordering, action space or heterogeneity of private information impact cascade behavior. Other papers focus on how cascades can be prevented in order to improve the flow of public information and maximize overall welfare. But what has been spared so far is the fact that herding behavior might actually have been caused by an individual or an institution deliberately "seeding" informational cascades. Historical evidence for cascades that have been intentionally created is substantial. The roman emperor Nero ensured the success of his personal stage performances by placing groups of soldiers in the audience whose role was to prompt overwhelming applause. This practice was later professionalized in 18th century Paris by the "Assurance de succès dramatique". This private company offered professional spectators who where paid to push the success of theatre plays by heavily applauding or making positive comments in the break. And in 1995, a management book appeared on the New York Times bestseller list not because of a great number of enthusiastic readers, but rather because 10,000 copies of that book had been strategically purchased from retailers whose sales reports were used as data basis for the bestseller list (Stern (1995)).

These examples point to a domain in which cascade seeding seems to offer significant potential, thus appearing to be of particular relevance: Superstar phenomena. Following Rosen, superstars are producers of particular goods that "earn enormous amounts of money and seem to dominate the fields in which they engage" (Rosen (1981), 845). The empirical results presented in the second paper of this dissertation, show that informational cascades contribute significantly to the emergence of superstars in markets in which consumers have only imperfect information with regard to the quality of goods that are offered. Given the relevance of informational cascades with regard to consumer choice, it is reasonable to assume that cascades do not necessarily develop "naturally". This paper presents a cascade framework which includes an influencer who, by providing private incentives to individual decision makers, aims at seeding cascade behavior. The framework reveals which incentive strategy the influencer should follow in order to maximize his payoff. Based on these theoretical findings, the paper analyzes whether informational cascades provide an effective tool for aspirants to stardom who seek to push their career by manipulating consumer behavior.

The remainder of the paper is structured as follows. Section (2) presents a basic cascade model with a single influencer, and investigates when the influencer has to provide incentives in order to seed cascade behavior and maximize his payoff. Section (3) reveals how the influencer has to adjust his payoff maximizing strategy if individual assumptions of the basic model are relaxed. Section (4) outlines the implication of cascade seeding within the realms of stardom, and shows the implications of a decision context in which two influencers seek to manipulate collective decision processes. A brief glance into the potential of cascade seeding by public institutions is provided in section (5). Section (6) concludes the findings, discusses potential extensions of the model and provides a brief introduction into how the findings of this paper can be validated empirically.

2 Basic Model with an Influencer

Assume a group of $m = 2k$ individuals with $k \in \mathbb{N}^*$. These individuals, risk-neutral maximizers of expected payoff, have to make a simple binary decision: Each individual i with $i = 1, 2, ..., m$ has to decide whether to adopt or to reject a certain behavior.[1] The payoff to adopting is denoted by V and is

[1]The setting described here is similar in spirit to the model presented by Bikhchandani, Hirshleifer and Welch (1992, 996) which in the following is referred to as "BHW model".

either $v^h = 1$ or $v^l = 0$ with equal prior probability. Rejecting yields a payoff of 0. It is assumed that the true payoff, which an individual receives based on his decision, is private information. An individual who adopts has to bear costs of $c = \frac{1}{2}$.

Every individual i is allowed to make only one decision and decisions are made sequentially. The order in which individuals decide is exogenously determined and known to all. Time consists of countable decision periods t and there are two decisions per period. Consequently, individuals one and two make their decision in period $t = 1$, individuals three and four in period $t = 2$ and so forth until period $t = \frac{m}{2}$.

When assessing the true value of V, every individual i has access to two sources of information. First, he observes the history of his predecessors' actions (A_i) and infers from the respective adopt or reject decisions the posterior probability that $V = v^h$. Second, he observes a private signal s_i which is either a "high signal" ($s_i = h$) or a "low signal" ($s_i = l$). The probability to observe either signal is conditional on the true value of V. The probability that an individual observes a high signal if $V = v^h$ is p and $1-p$ if $V = v^l$. Probability p thus captures how much information an individual i has about the true value of V or alternatively the quality of his private information. This information is informative with $p \in \left(\frac{1}{2}, 1\right)$. Individuals have homogeneous private information and, as a result, observe either signal with equal probability. Signal probabilities are summarized in table (1).

Table 1: Signal probabilities

The table shows the conditional probabilities that an individual i observes a high signal ($s_i = h$) or a low signal ($s_i = l$) given that $V = v^h$ or $V = v^l$ and with $p \in \left(\frac{1}{2}, 1\right)$.

	$P(s_i = h\|V)$	$P(s_i = l\|V)$
$V = v^h$	p	$1-p$
$V = v^l$	$1-p$	p

Based on these two sources of information, individuals determine the posterior probability that $V = v^h$ denoted by γ_i which, following Bayesian inference, is

$$\gamma_i = P(v^h|s_i, A_i) = \frac{P(s_i, A_i|v^h) \cdot P(v^h)}{P(s_i, A_i|v^h) \cdot P(v^h) + P(s_i, A_i|v^l) \cdot P(v^l)} \tag{1}$$

With $v^h = 1$ and $v^l = 0$ the expected payoff of adopting, denoted by $E[\Pi_i]$, is

$$E[\Pi_i] = \gamma_i - c \tag{2}$$

An individual adopts if $E[\Pi_i] > 0$ and rejects if $E[\Pi_i] < 0$. As a tie breaking assumption, an individual flips a coin if he is indifferent between adopting and rejecting, i.e. $E[\Pi_i] = 0$.

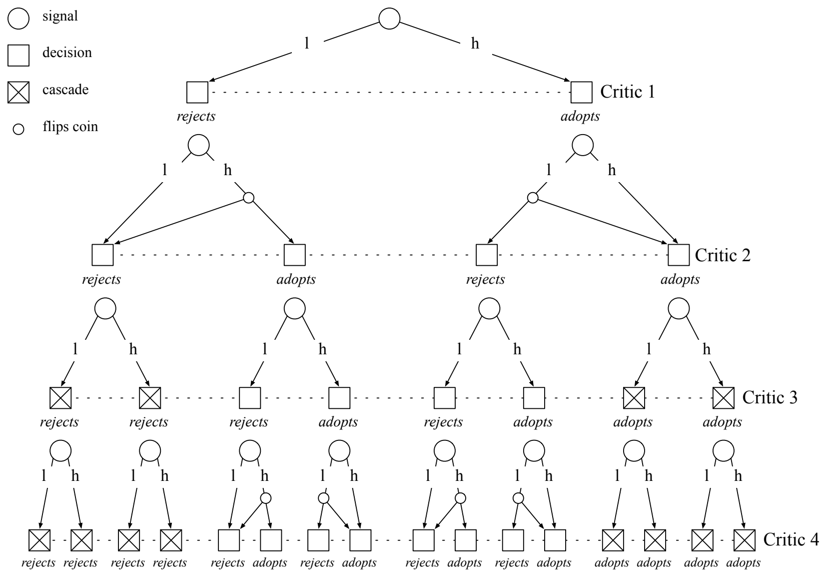
In contrast to the BHW model, the model presented here includes an influencer who is able to manipulate the decision sequence by deliberately seeding informational cascades. A cascade is seeded by convincing two individuals of the same period to either adopt, which creates an up cascade, or to reject, which starts a down cascade. It is assumed that the influencer receives a payoff of $\frac{1}{2}$ for every adopt decision and a payoff of 0 for every individual who rejects. He is therefore interested in the formation of an up cascade which induces individuals to adopt. Decisions are manipulated through incentives that the influencer can provide to convince individuals. These incentives are private information and individuals are "naive" with respect to the presence of the influencer. This means that an individual i does not know that the influencer is manipulating the decision process until an incentive b_i is actually proposed to him. Once an individual is aware of the influencer, it is assumed that he ignores his predecessors' behavior and relies exclusively on his own private signal. Individuals have no information on the influencer's payoff structure. The influencer knows the true state of V as well as signal quality p but has no information on individuals' private signals. By assumption, once a cascade has started the influencer can no longer intervene. This assumption is in fact plausible since an individual, deciding against a cascade, would be judged irrational and his decision would not be included in the decision making process of remaining individuals.

The following example illustrates how an influencer can deliberately create cascade behavior. In this example, the influencer is a winemaker who faces a group of six wine critics. In order to promote his wine, the winemaker aims at seeding an up cascade which prompts the critics to write positive reviews. For the first critic of the decision sequence the case is simple: If he observes a high signal then $\gamma_1 = p$ and, as a consequence, his expected payoff is $E[\Pi_1] = p - \frac{1}{2} > 0$. If he observes a low signal, then he will publish a negative review since $\gamma_1 < \frac{1}{2}$ and thus $E[\Pi_1] < 0$. Assume that critic number one has observed a high signal, has published a positive review and that critic number two, who has read his predecessor's review, has observed a low signal. The resulting posterior probability that the wine is of high quality is $\gamma_2 = \frac{1}{2}$. Therefore, the second critic is indifferent between a positive and a negative review and flips a coin. For the sake of illustration, assume that the coin induces the second critic to publish a negative review. In this case, the third critic is in the same position as critic number one. He knows that the first critic has observed a high signal, and that the second critic has observed a low signal. In order to convince critic number three to publish a positive review, the winemaker has to offer him an incentive b_3 which "neutralizes" this critic's private signal. Since this signal is potentially contrary to the decision which the winemaker wants him to make, he has to provide an incentive of $b_3 = c - \gamma_1 = p - \frac{1}{2}$. In this case, after having received an incentive, this critic is indifferent and flips a coin. By providing an incentive of $b_3 = p - \frac{1}{2} + \epsilon$ with ϵ being arbitrarily small, the critic is no longer indifferent and writes a positive review. If the winemaker has convinced critic number three to praise his wine and does now persuade critic number four to write a positive review as well, then he has to provide this critic with an incentive b_4. And since offering an incentive unveils the winemaker's intentions, convincing this critic requires the same incentive as critic number three: $b_4 = p - \frac{1}{2} + \epsilon = b^*$. This incentive b^* is independent of a critic's decision history A_i and only depends on signal quality p. The fifth critic in the decision sequence has observed that his two predecessors have raved about the wine and, as a consequence, he will also publish a positive review no matter whether his private signal is $s_5 = h$ or $s_5 = l$. This critic's decision is subject to an informational cascade. Due to this cascade, the last two critics of the decision sequence join the bandwagon and publish positive reviews while ignoring their private information. The potential decision paths of the first four critics are illustrated in figure (1).

In the example outlined above, the winemaker has seeded an up cascade in the second period of the decision sequence. This cascade convinced the last two wine critics to praise his wine independent of their private information. In order to create the cascade, the winemaker had to provide an incentive of $b_3 = b^*$ to critic number three and another incentive of $b_4 = b^*$ to critic number four. But would the winemaker have been better off by intervening

Figure 1: Potential decision paths in the wine example

This figure illustrates the first four wine critics' decision to publish either a positive review ("adopt") or a negative review ("reject") on the wine depending on whether a critic observes a low signal ("l") or a high signal ("h").



earlier in the decision sequence and by seeding the cascade in period $t = 1$? Or would his payoff have been higher by leaving critics' decisions to chance and not intervening at all? In order to maximize his payoff, the influencer has to weigh the costs against the benefit of providing incentives. The benefit of providing incentives is the extra payoff certainty which the influencer receives.

In order to determine the optimum incentive strategy which maximizes the winemaker's expected payoff $E[\hat{\Pi}]$, he has to apply backward induction and thus "think ahead and reason back". In the example outlined above, period three is the last period of the decision sequence. In this period, critics five and six find themselves in three possible situations. First, they are already in a down cascade in which case it is too late for the winemaker to intervene. Second, they are in an up cascade and the intervention of the winemaker is no longer necessary. Third, no cascade has developed yet and the winemaker is still able to influence their decision. Following Bikhchandani, Hirshleifer and Welch (1998, 155), the influencer's action space can be defined based on the difference between the number of adopting individuals and rejecting individuals denoted by δ. If $\delta < 0$ indicates a dominance of reject decisions, then a down cascade forms as soon as $\delta < -1$. In this case, the influencer can no longer intervene. An up cascade forms as soon as $\delta > 1$. In the remaining cases, the influencer can either influence individual decisions by providing incentives or decide not to intervene. Table (2) provides an overview of the influencer's actions space.

Table 2: Action space of the influencer

The table summarizes the action space of the influencer based on the difference δ between the number of adopt decisions and the number of reject decisions given that $\delta > 0$ indicates a majority of adopt decisions.

δ	*Action space*
$\delta > 1$	An up cascade has already formed and intervention is no longer needed
$\delta = \{-1, 0, 1\}$	The influencer can either provide an incentive or decide not to intervene
$\delta < -1$	A down cascade has already formed and intervention is no longer possible

If critic number five is not in a cascade and has not yet published his review, then it follows that $\delta = 0$. In this case, the winemaker can choose between providing incentives to this critic and the following critic or just passively observing these critics' decisions. Even though a cascade is no longer possible, since this is the last period of the decision sequence, the influencer would still receive a certain payoff of 1 in return for the incentives he provides. Assuming that the winemaker knows that the wine he is promoting is of high quality ($V = v^h$), then his expected payoff of not intervening in this period is

$$E[\hat{\Pi}^{b_5=b_6=0}] = p \tag{3}$$

If he intervenes in period number three, his payoff is

$$E[\hat{\Pi}^{b_5=b_6=b^*}] = 1 - 2b^* \tag{4}$$

It follows that the winemaker should provide incentives to these two critics if

$$1 - 2b^* > p \tag{5}$$

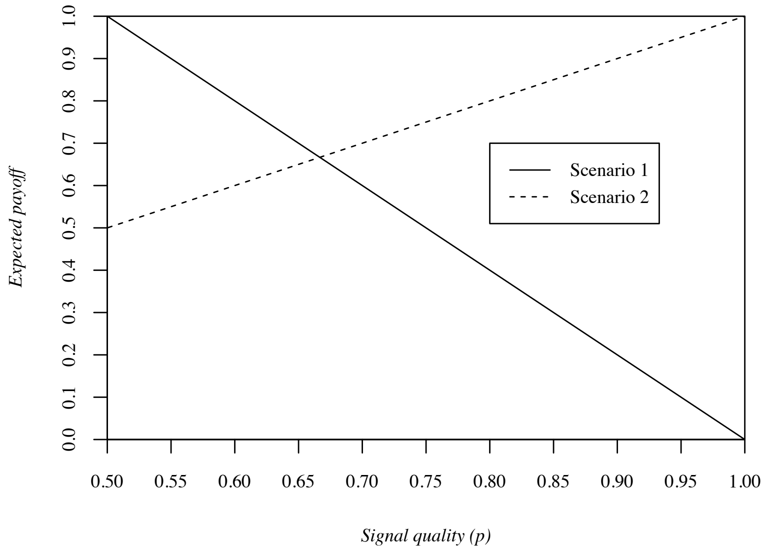
Therefore, incentives should be provided if

$$2b^* < 1 - p \tag{6}$$

Inequality (6) shows that providing incentives is the payoff maximizing strategy if the benefit of intervening, i.e. the difference between the certain payoff if both critics publish positive reviews and the expected payoff exceeds the costs of intervening. This inequality also reveals that the winemaker's optimum action depends on p: If $p^* < p < 1$ with $p^* = \frac{2}{3}$, then the winemaker maximizes his payoff by passively hoping that these critics write favorable reviews. If $\frac{1}{2} < p < p^*$, the winemaker should intervene in this period in order to prevent these critics from condemning his wine. If $p = p^*$, the wine maker is indifferent between both options. The value p^* therefore constitutes an equilibrium value below which providing incentives results in a higher payoff than leaving individuals' decisions to chance. The payoff of the winemaker in this period of the decision sequence is illustrated in figure (2) as a function of signal quality p.

Figure 2: Payoff of the winemaker in $t = 3$ with $V = v^h$

The figure shows the winemaker's payoff in period $t = 3$ as a function of signal quality p given that critics number five and number six have received (scenario 1) or not received (scenario 2) incentives given that $V = v^h$.



In order to assess the winemaker's optimum strategy with regard to period $t = 2$, he has to take into account whether he will provide incentives in the following period or if he will leave the the decisions of critics number five and six to chance. In the first case, the winemaker should seed the cascade in the second period if

$$2b^* < 2 - \left(p(1+p) + p(1-p)\left(\frac{3}{2} - 2b^*\right)\right) \tag{7}$$

Since inequality (7) holds true for all $p \in (\frac{1}{2}, \frac{2}{3})$, it follows that the winemaker should seed the cascade in the second period instead of providing incentives in period number three. If the winemaker knows that he will leave the decisions of the third period to chance because $\frac{2}{3} < p < 1$, then seeding the cascade in the second period is the payoff maximizing strategy if

$$2b^* < 2 - \left(p(1+p) + p(1-p)\left(\frac{1}{2} + p\right)\right) \tag{8}$$

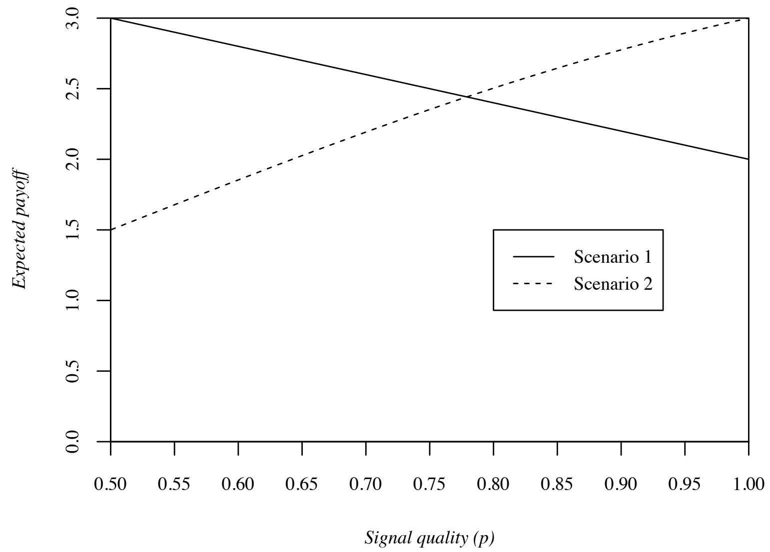
In this case, the winemaker has to differentiate once again. If $p^* < p < 1$ with $p^* \approx 0.7385$, then he should also not intervene in this period and passively observe whether the critics write positive or negative reviews. However, if signal quality is below this new equilibrium value p^*, it is payoff maximizing for the influencer to seed the cascade in this period.

Since the winemaker now knows how to proceed in period $t = 2$ and $t = 3$, he moves on to the first period and assesses whether "bribing" the first and the second critic yields a higher expected payoff than passively observing the decisions of these critics. If he knows that he will seed the cascade in the second period because $\frac{1}{2} < p < p^*$ with $p^* \approx 0.7385$, then it follows that the payoff maximizing strategy is to start the cascade in period number one. The result would be that all six critics praise the wine: The first two critics because they have received incentives and the other four critics because they are part of an informational cascade. However, if he does not intend to intervene in the following two periods, then not intervening in the first period is only the optimum strategy if $p^* < p < 1$ with $p^* \approx 0.7791$. Consequently, if signal quality is below this equilibrium value p^*, then the winemaker should seed the cascade right away by providing incentives to the first two critics. If signal quality is above p^*, then the winemaker maximizes his payoff by not intervening at all. Figure (3) illustrates these findings.

The example above has revealed that the optimum strategy depends on signal quality p. Hence, the influencer has to account for how much decision

Figure 3: Payoff of the winemaker in $t = 1$ with $V = v^h$

The figure indicates the winemaker's payoff as a function of signal quality p given that he seeds cascade behavior in the first period (scenario 1) and given that he does not provide any incentives (scenario 2).



makers know about the true value of the underlying state variable V in order to determine his payoff maximizing strategy. This result is quite evident: The higher p and thus the better individuals are informed about whether adopting is favorable or disadvantageous, the higher the required incentive to convince an individual to make a certain decision. Or to put it differently: It takes more to convince a connoisseur than a novice. On the other hand, a high p reduces the probability of reject decisions as well as a down cascade and thus, from the perspective of the influencer, the necessity of intervention given that $V = v^h$. Table (3) summarizes this rationale.

In the wine example, the winemaker faced a group of six wine critics. The question is how the influencer should intervene if he faces a decision sequence of $m > 6$, and how the length of the decision sequence impacts the influencer's optimum strategy.

> **Proposition 1:** *Given that $V = v^h$, the longer the decision sequence the higher the equilibrium value p^* below which seeding an up cascade in period number one is the payoff maximizing strategy.*

Proof The influencer's payoff if seeding an informational cascade at the

Table 3: Impact of signal quality on the payoff of the influencer

	Low signal quality	*High signal quality*
Effect on payoff if influencer intervenes	Higher payoff since individuals are easily convinced to decide against their signal	Lower payoff since high incentives are required to convince individuals
Effect on payoff if influencer does not intervene	Lower payoff due to a high chance that individuals err and that a down cascade develops	Higher payoff due to a high chance that individuals adopt and that an up cascade develops "naturally"

beginning of a decision sequence, i.e. if following an active strategy, is

$$E[\hat{\Pi}^a] = \frac{1}{2}m - 2b^* \tag{9}$$

In this case, all individuals adopt, either because they have received an incentive or because an informational cascade prompts them to do so. It follows that

$$\frac{\partial E[\hat{\Pi}^a]}{\partial m} = \frac{1}{2} \tag{10}$$

Consequently, the influencer's payoff increases by one if the decision sequence is extended by one period. This result is evident because the longer the decision sequence, the higher the payoff which he receives in return for the two incentives that he has to provide in order to set off the cascade. It also follows that

$$\frac{\partial E[\hat{\Pi}^a]}{\partial p} < 0 \tag{11}$$

This result is in line with the conclusion drawn from the wine example: The higher the quality of individuals' private signals the higher the incentives which are required to convince them and thus the lower the payoff.

If the influencer does not intervene and therefore follows a passive strategy his expected payoff is

$$E[\hat{\Pi}^p] = \frac{1}{2}\alpha^h \tag{12}$$

In this payoff function, α^h captures the expected number of individuals who adopt given that $V = v^h$. This number depends on the length of the decision sequence as well as the quality of private signals:[2]

$$\alpha^h = \frac{m}{2}\left(p - p^2\right)^{\frac{m}{2}} + \sum_{i=0}^{\frac{m}{2}-1}\left(p - p^2\right)^i \left(\frac{m}{2}\left(p + p^2\right) + i\left(1 - 2p\right)\right) \tag{13}$$

It follows that

$$\frac{\partial \alpha^h}{\partial m} < 1 \tag{14}$$

And therefore an increase in m has the following effect on the payoff of following a passive strategy:

$$\frac{\partial E[\hat{\Pi}^p]}{\partial m} < \frac{1}{2} \tag{15}$$

Hence, the effect of an increase in m on the payoff of the influencer is weaker relative to the impact on the payoff of following an active strategy. This result is evident since $p < 1$. Differentiating $E[\hat{\Pi}^p]$ with respect to p shows that

$$\frac{\partial E[\hat{\Pi}^p]}{\partial p} > 0 \tag{16}$$

In this case, an increase in p positively effects the influencer's payoff because a higher signal quality results in a higher probability that individuals adopt. The equilibrium value p^* is defined by

$$E[\hat{\Pi}^p] = E[\hat{\Pi}^a] \tag{17}$$

Consequently, if an increase in m has a stronger effect on the payoff of following an active strategy, it follows that p^* has to increase in order to compensate this difference in payoff relative to the payoff of a passive strategy. It also follows that, if not intervening is the payoff maximizing option in period $t = 1$, then the influencer should not intervene in any period $1 < t \leqslant \frac{m}{2}$.

> **Proposition 2:** *If $m \to \infty$ then the influencer should seed an up cascade in the first period of the decision sequence independent of signal quality p.*

[2] Please see appendix (A.2) for detailed information on how the expected number of adopt decisions is determined.

Proof Seeding an informational cascade in the first period of the decision sequence is the payoff maximizing strategy if

$$\begin{aligned} \frac{1}{2}m - 2b^* &> \frac{1}{2}\alpha^h \\ 4b^* &< m - \alpha^h \end{aligned} \tag{18}$$

The right side of this inequality is the difference between the number of adopt decisions which result if the influencer seeds a cascade in period number one and the expected number of adopt decisions if the influencer does not intervene. It follows that

$$\begin{aligned} m - \alpha^h &= m - \frac{m}{2}\left(p - p^2\right)^{\frac{m}{2}} - \sum_{i=0}^{\frac{m}{2}-1}\left(p - p^2\right)^i\left(\frac{m}{2}\left(p + p^2\right) + i\left(1 - 2p\right)\right) \\ &= m - \frac{m}{2}\left(p - p^2\right)^{\frac{m}{2}} - \frac{m}{2}\left(p + p^2\right)\frac{1 - \left(p - p^2\right)^{\frac{m}{2}}}{1 - \left(p - p^2\right)} \\ &\quad - \left(1 - 2p\right)\frac{\left(\frac{m}{2} - 1\right)\left(p - p^2\right)^{\frac{m}{2}+1} - \frac{m}{2}\left(p - p^2\right)^{\frac{m}{2}} + \left(p - p^2\right)}{\left(\left(p - p^2\right) - 1\right)^2} \end{aligned} \tag{19}$$

Given that $p \in \left(\frac{1}{2}, 1\right)$, it follows that

$$\lim_{m\to\infty}\left(m - \alpha^h\right) = \infty \tag{20}$$

Therefore, if $m \to \infty$ then $4b^* < m - \alpha^h$ for all $p \in (\frac{1}{2}, 1)$. The influencer should therefore seed a cascade in the first period of the decision sequence independent of signal quality p if he faces a decision sequence of infinite length. Even if the length of the sequence is finite, the equilibrium value p^* is close to one given that the influencer faces a large group of decision makers. For example, if $m = 1,000$ then seeding an informational cascade is the payoff maximizing strategy for all $p \in (\frac{1}{2}, p^*)$ with $p^* \approx 0.9961$.

In the example of the six wine critics, the winemaker knows that he is producing a high quality wine. Hence, he has to convince individuals to make a decision that is favorable. What if the winemaker is trying to promote a low quality wine? Or generally speaking: What if the influencer has to seed a cascade that induces individuals to make a choice which they would not make in an economy of perfect information?

Going back to the last period of the decision sequence in the wine example, if $V = v^l$ then the winemaker can either provide incentives to critics number five and number six and receive a payoff of

$$E[\hat{\Pi}^a] = 1 - 2b^* \tag{21}$$

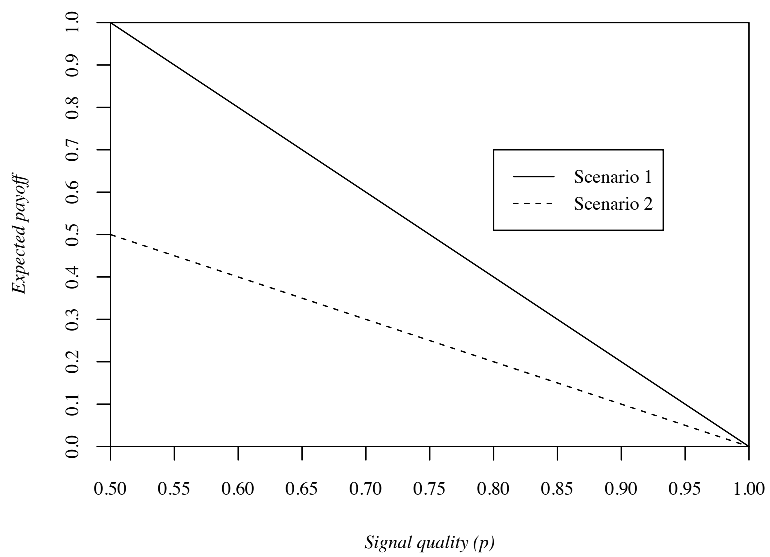
Or, he decides not to intervene and just observe the critics' decisions. In this case, his expected payoff is

$$\begin{aligned} E[\hat{\Pi}^p] &= (1-p)\left(\frac{1}{2} + \left(1 - \frac{1}{2}p\right)\frac{1}{2}\right) + p\left(\frac{1}{2}(1-p)\right)\frac{1}{2} \\ &= 1 - p \end{aligned} \tag{22}$$

As figure (4) shows, in this case providing incentives is the payoff maximizing strategy independent of signal quality p. Compared to the high quality scenario, critics are more likely to write negative reviews and therefore it does not pay off for the winemaker to passively observe whether critics "naturally" praise the wine.

Figure 4: Payoff of the winemaker in $t = 3$ with $V = v^l$

The figure shows the winemaker's payoff in period $t = 3$ as a function of signal quality p given that critics number five and number six have received (scenario 1) or not received (scenario 2) incentives and given that $V = v^l$.



Proposition 3: *If $V = v^l$, then the influencer maximizes his payoff by seeding an up cascade in the first period independent of signal quality p and the number of individuals m.*

Proof If $V = v^l$ and $m = 2$ then, as the assessment of the last period in the wine example has already shown, it follows that

$$\underbrace{1 - 2b^*}_{E[\hat{\Pi}^a]} > \underbrace{1 - p}_{E[\hat{\Pi}^p]} \quad , \quad p \in \left(\frac{1}{2}, 1\right) \tag{23}$$

In this case, following an active strategy is always payoff maximizing independent of signal quality p. The expected number of adopt decisions for any m given that $V = v^l$ is

$$\alpha^l = \frac{m}{2}\left(p - p^2\right)^{\frac{m}{2}} + \sum_{i=0}^{\frac{m}{2}-1}\left(p - p^2\right)^i \left((1-p)\left(1 - \frac{1}{2}p\right)m + (2p-1)i\right) \tag{24}$$

It follows that

$$\begin{aligned} \frac{\partial E[\hat{\Pi}^p]}{\partial m} &< \frac{1}{2} \\ \frac{\partial E[\hat{\Pi}^p]}{\partial p} &< 0 \end{aligned} \tag{25}$$

And as a consequence

$$\frac{1}{2}m - 2b^* \; > \; \frac{1}{2}\alpha^l \quad , \quad p \in \left(\frac{1}{2}, 1\right) \quad , \quad m \geqslant 2 \tag{26}$$

Therefore, seeding an informational cascade in the first period of the decision sequence is the payoff maximizing strategy independent of group size m and signal quality p given that $V = v^l$.

3 Extensions of the Model

3.1 Anticipated Incentives

The basic setup of the model is based on the assumption that individuals are not aware of the influencer until an incentive is actually proposed to them.

This assumption has a significant impact on the information individuals extract from other individuals' behavior. It is reasonable to assume that the majority of decision situations are with higher or lower probability affected by private incentives, and individuals are expected to include this probability in their decision rationale. If individuals know with certainty that an influencer is manipulating the decision process through private incentives, the result would be general suspiciousness. In this situation, decisions convey no information at all, and every individual solely relies on his own private information.

> **Proposition 4:** *Even if individuals have information on the presence of an influencer, cascades can still be seeded as long as this information is imperfect.*

Proof In the example of the wine critics, assume that the first critic published a positive review. The second critic tries to defer his predecessor's private signal by observing his behavior and, at the same time, assumes with probability λ and $\lambda \in [0, 1]$ that positive reviews have been "encouraged" by private incentives. The posterior probability that the wine is of high quality given that the first critic has published a positive review is

$$P(v^h|A_2) = \frac{p + (1-p)\lambda}{1+\lambda} \tag{27}$$

If $\lambda > 0$ the first critic's review is less informative for those critics who follow in the decision sequence. If the second critic knows with certainty that an influencer is intervening because an incentive has been proposed to him then $\lambda = 1$. Consequently, the first critic's decision is completely uninformative since $P(v^h|A_2) = \frac{1}{2}$.

Assume that the first four critics have chosen to publish a favorable opinion on the wine, that the fifth critic observes a signal $s_5 = l$ and believes with probability $\lambda = 0.2$ that his predecessors' reviews were affected by private incentives. As a result, the posterior probability for $V = v^h$ is

$$\gamma_5 = P(v^h|s_5, A_5) = \frac{(p + 0.2(1-p))^4(1-p)}{(p + 0.2(1-p))^4(1-p) + ((1-p) + 0.2p)^4 p} \tag{28}$$

In this case, given that $p < p^*$ with $p^* \approx 0.9330$, he will join his fellow critics' decision despite his private signal and his behavior is thus subject to an informational cascade. As a result, even though individuals know that an influencer is potentially manipulating individual decision making, cascade behavior can still emerge and therefore still be seeded. The lower λ, the faster cascade behavior develops given a certain p. On the other hand, with $\lambda > 0$ slowing the development of cascade behavior down, more individuals have to be convinced and therefore the costs for seeding cascade behavior increase.

3.2 Influencer with Imperfect Information

In contrast to the basic model outlined in section (2), the influencer might find himself in an economy in which he, just like the decision makers, has only imperfect information with regard to the true value of V. In the wine example, the winemaker could have imperfect information with regard to the true quality of his wine. For instance, he could question whether the wine he is producing actually corresponds to current taste. Or, if the influencer's role is played by the winemaker's distributor, this distributor might not know with absolute certainty whether the wine he is selling is actually of high or of low quality.

Assume that the influencer has only imperfect information on the true value of V and that, similar to the private information of individuals, he observes either a high signal or a low signal. If $V = v^h$, he observes a high signal with probability $\hat{p}$ and a low signal with probability $1 - \hat{p}$ given that $\hat{p} \in \left(\frac{1}{2}, 1\right)$. If $V = v^l$, then signal probabilities are inverse.

> **Proposition 5:** *Given that the influencer observes a low signal and that $\hat{p} = p$, then he maximizes his payoff by seeding a cascade in the first period of the decision sequence independent of signal quality p and the number of individuals m.*

Proof If the influencer observes a low signal then providing incentives is payoff maximizing if

$$\frac{m}{2} - 2b^* > \frac{1}{2}\left(\hat{p}\alpha^l + (1 - \hat{p})\alpha^h\right) \tag{29}$$

With $\hat{p} = p$ it follows that

$$\frac{m}{2} - 2b^* > \frac{1}{2}\left(\alpha^h - p\left(\alpha^h - \alpha^l\right)\right) \tag{30}$$

Since this inequality holds true for all $p \in \left(\frac{1}{2}, 1\right)$ and all $m \geqslant 2$, the influencer should always seed cascade behavior in the first period of the decision sequence independent of group size m and signal quality p.

Proposition 6: *Given that the influencer observes a high signal and that $\hat{p} = p$, then the optimum strategy depends on group size m and signal quality p.*

Proof Given that the influencer has observed a high signal, then seeding a cascade in the first period of the decision sequence is the optimum strategy if

$$\frac{m}{2} - 2b^* > \frac{1}{2}\left(\hat{p}\alpha^h + (1-\hat{p})\alpha^l\right) \tag{31}$$

With $\hat{p} = p$ it follows that

$$\frac{m}{2} - 2b^* > \frac{1}{2}\left(\alpha^l + p\left(\alpha^h - \alpha^l\right)\right) \tag{32}$$

In the case of $m = 2$, intervening is only payoff maximizing if $\frac{1}{2} < p < p^*$ with $p^* \approx 0.7071$. Similar to the economy in which the influencer has perfect information on the true value of V, the equilibrium value p^* increases with the length of the decision sequence. And it also follows that, given a particular m, the equilibrium value p^* is higher relative to the equilibrium value in a scenario of perfect information due to the influencer's uncertainty.

What has been implicitly assumed here is that the influencer defines his strategy before the first individual makes his decision. However, if the influencer can adjust his strategy after the decision sequence has already started, then he is able to learn from individuals' behavior and might therefore switch strategies.

3.3 Biased Expectations

Before observing their private signal, the critics of the wine example have a neutral view on the true quality of the wine in question. However, critics might have biased expectations, if, for example, the winemaker is known for making bad wine. In order to reflect biased expectations, the basic model is extended by including a coefficient β which is common knowledge and affects individuals' rationale in the following way:

$$\gamma_i = P(v^h|s_i, A_i) = \frac{P(s_i, A_i|v^h)}{P(s_i, A_i|v^h) + \beta \cdot P(s_i, A_i|v^l)} \tag{33}$$

This coefficient β captures how individuals perceive the likeliness of $V = v^l$ relative to $V = v^h$:

$$\beta = \frac{P(v^l)}{P(v^h)} \tag{34}$$

By definition $P(v^l)+P(v^h) = 1$ and $P(v^h), P(v^l) \in (0,1)$. If $\beta < 1$, individuals are biased towards adopting. This state is referred to as up bias. If $\beta > 1$, a down bias induces individuals to be inclined towards rejecting. In the case of $\beta = 1$, individuals have neutral expectations which lead to the results that have been described in section (2). The probabilities with which individuals observe either signal remain unchanged.

Assume that $\beta > 1$ and that the influencer has provided incentives to the first two individuals of the decision sequence, and that the third individual has observed a low signal. In the basic model, the two observed adopt decisions would convince the third individual to also adopt independent of his private signal. But in the case of a down bias, the resulting posterior probability that $V = v^h$ is

$$\gamma_3 = \frac{p}{p + (1-p)\beta} \tag{35}$$

If $\beta < \frac{p}{1-p}$, this individual adopts despite his private information and is thus caught in a cascade. However, if $\beta > \frac{p}{1-p}$, he only adopts if the influencer provides him with an incentive as well. Hence, a down bias results in higher incentive costs for the influencer since more individuals have to be convinced until a cascade develops. The incentive, which has to be provided in order to convince an individual, who has observed a low signal, to adopt is

$$b^* = \frac{1}{2} - \frac{1-p}{1+(\beta-1)p} + \epsilon \tag{36}$$

It follows that

$$\frac{\partial b^*}{\partial \beta} = \frac{p-p^2}{((1-p)+\beta p)^2} > 0 \tag{37}$$

Equation (37) shows that a down bias increases incentives which the influencer has to provide. As a result, given that $\beta > 1$, incentive costs are not only higher compared to an economy with neutral expectations because more decisions are needed to commence a cascade, but also because individual incentives are more expensive. Evidently, an up bias has the opposite effects and therefore increases the influencer's expected payoff.

3.4 Heterogeneous Payoffs or Preferences

The basic model assumes that individuals are homogeneous and that the respective choices are based on the same set of preferences. Consequently, all individuals face the same payoff structure when assessing whether to adopt or reject a certain behavior: The payoff is either 1 or 0 and solely depends on the decision that has been made and the true value of V. Most decision contexts however include individuals with heterogeneous preferences who value the same decisions differently. In an extreme case, the respective preferences might be completely opposing. How are informational cascades affected by individuals with heterogeneous preferences? And how do different preferences impact the influencer's optimum strategy? As Bikhchandani, Hirshleifer and Welch (1998, 161) note, the effect of different preferences depends on whether preferences are public information or not.

If preferences are public information, the impact of heterogeneous payoffs on the outcome of decision sequences is straightforward. Individuals simply include the respective preferences in their rationale when deducing information on the true value of V from the observed behavior of other individuals unless, of course, a cascade has already started. As a result, it might take longer for cascades to form since individuals with particular preferences only include the decision of individuals with the same preferences in their decision making. Still, as Bikhchandani, Hirshleifer and Welch (1998, 161) point out, as soon as the decisions of individuals with the same preferences are strong enough to outbalance ones private information cascade behavior develops. Therefore, even if individuals have heterogeneous preferences an influencer can still seed cascades. But differing preferences affect the incentives that an influencer has to provide to create a cascade. On the one hand, optimum incentives have to reflect the individual's type with regard to the value of the incentive. For example, the higher an individual values an adopt decision relative to a reject decision, the lower the incentive that is necessary to convince this individual. Obviously, the contrary holds true if an individual's type is biased towards a reject decision. It takes quite a significant incentive to convince a vegetarian to choose a steakhouse instead of a salad bar. On the other hand, heterogeneous types of individuals impact the influencer's decision with regard to which individuals should receive an incentive. In the case of opposing preferences, only individuals whose decisions do have an impact on the cascade behavior the influencer is trying to seed should be candidates for private incentives. It is important to note that, similar to the basic model, the influencer can only provide incentives as long as the decision of an individual is still considered rational from the perspective of the remaining individuals who are not aware of the incentive scheme. An individual, who is known for his exceptional love of French cuisine, would seed doubts in his rationality when suddenly avoiding this type of food.

If the type of every individual is only private information, observational learning as well as providing incentives becomes more complex. Decision uncertainty is increased because an individual does not know with certainty why his predecessors have made certain decisions. An individual adopting might have chosen this action either because he has observed a positive signal or because he has been biased towards this decision due to his particular payoff structure.[3] If probabilities for different types are publicly known, individuals and influencer can include this information in their rationale. In both cases, the rate of learning and hence the formation of cascade behavior is slowed down, the probability of wrong cascade increases and, as a consequence, providing incentives results in higher costs for the influencer.

To conclude, differing payoffs or preferences add noise to the decision context. This noise slows observational learning down and makes it more difficult for the influencer to intervene and influence individual behavior. But as long as individuals are bound within a discrete action space and base their decisions on observations of other individuals' behavior, cascades eventually form and can thus be deliberately triggered by the influencer.

3.5 Heterogeneous Signal Quality

In most markets, individuals do not only differ with regard to payoffs or preferences, but also with respect to how much information they have on the true value of options between which they are able choose. For example, a wine connoisseur has an informational advantage when deciding which wine to buy

[3]As Hirshleifer and Teoh (2003, 37) note, an individual's decision might also be the result of imperfect rationality. In this model here individuals presume rational behavior and thus do not question the rationality of other individuals' decisions.

compared to an average customer. Individuals who have superior knowledge and observe more precise private signals are commonly referred to as "fashion leaders" in cascade literature (Bikhchandani, Hirshleifer and Welch (1992), 1002). These fashion leaders play an important role in decision contexts where decision uncertainty is significant. In stock markets, for example, the buy or sell decision of investors who are believed to have superior information are often copied by other investors (Zhou and Lai (2009), 392). How much influence a fashion leader has on a group of decision makers and how an influencer can capitalize on this influential power depends on the fashion leader's position in the decision sequence.

If an individual, who has a higher quality of information than his fellow decision makers, is the first to make his decision and if his informational superiority is public information, his decision is immediately copied by following individuals and thus instantly triggers cascade behavior. Even if this expert has only slightly better information than others a cascade will develop. Hence, from the perspective of an influencer, individuals who act as fashion leaders have the potential to serve as catalysts and are of particular interest. By providing an incentive to the fashion leader and ensuring that he adopts, the influencer can effectively seed cascade behavior. This finding is in line with Bikhchandani, Hirshleifer and Welch (1992, 1003) who argue that an individual who is willing to bring about social change should focus on convincing opinion leaders. This explains why movie stars, who many people perceive as role models for a glamorous and fashionable lifestyle, are paid for driving certain cars or wearing particular watch brands. This is especially true if the real value of any given good would induce an individual with perfect information to reject; in these situations the influencer should intervene early in the decision sequence and woo the fashion leader. This of course requires that the payoff for the influencer justifies the high incentive which is necessary in order to convince a fashion leader to adopt an unfavorable behavior.

A fashion leader with a later position in the decision sequence improves the aggregation of public information: First, because early decision makers rely more on their private signal, and second because a fashion leader is more inclined towards following his own information.[4] Bikhchandani, Hirshleifer

[4]That is why some courts have set up decision procedures requiring junior judges to vote before their more experienced colleagues in order to reduce imitative voting behavior (Hirshleifer (1993), 13).

and Welch (1992, 1004) conclude that an individual with better information deciding later in the decision sequence is able to break a cascade that has already formed and, because more information is aggregated, improves decision making. It is interesting to note that in this case, the group of individuals does not have to be aware of his informational superiority because when someone decides against a cascade others will automatically infer that this person has observed a private signal of higher quality given that behavior is considered rational. As a result, in the context of heterogeneous information, an influencer can intervene at any point in time of the decision sequence by turning any individual into a fashion leader simply by convincing him not to join the cascade. Consequently, an influencer can still manipulate collective decisions even if an informational cascade has already formed. Of course, this requires that individuals perceive a decision maker acting against a cascade as being better informed rather than being irrational or "bribed". On the other hand, this also means that, even if a cascade in the interest of the influencer has already formed, the influencer has to fear that a fashion leader deciding later in the decision sequence is able to break the cascade.

On the whole, the phenomenon of fashion leaders, from the perspective of an influencer, can be both beneficial and disadvantageous. But considering the fact that fashion leaders are generally the ones part of the early decision makers, they provide the influencer with the opportunity to effectively seed informational cascades and manipulate the masses.

3.6 Endogenous Timing of Decisions

In contrast to the basic model, in which decision ordering is exogenously determined and individuals therefore make their decision when they are told to do so, in most decision situations individuals not only choose which decision to make but also when to make that decision. According to Gale (1996, 622), if delaying a decision is free every individual would want to be last in order to gain additional information by observing what others are doing. But if waiting is costly, e.g. because of foregone dividends, individuals have to weigh the benefit of additional information against the costs incurred through waiting.

A number of papers have examined informational cascades based on theoretical frameworks that allowed for endogenous decision timing in combination with heterogeneous signal quality. Chamley and Gale (1994) show that, in

Bayesian equilibrium, equally informed individuals delay their decision until waiting costs equal the informational benefit of waiting. Furthermore, the extent of delay is positively related to period duration and negatively related to the number of decision makers. Building on this work, Chamley extends the theoretical framework allowing for varying signal quality. This model generates multiple equilibria in which agents either rush in the beginning of the decision sequence or in which most agents delay. The continuous time and continuous action space model by Gul and Lundholm (1995), reveals that individuals who are allowed to choose the timing of their decision tend to move together, which results in decision clustering. The authors also show that whether decision clustering is the result of an informational cascade largely depends on the richness of the players' action space. A continuous action space enables individuals to fully reflect their private information in their decision making, which prevents cascade behavior. Zhang (1997) allows for endogenous timing of a binary investment decision and action takes place in continuous time. In equilibrium, individuals delay in order to gain more information from the decision of others. Once investments are made by better informed individuals, subsequent investments follow instantly.

The following simple model described by Gale (1996, 618) provides a suitable theoretical fundament to examine cascade seeding in an environment in which individuals are able to time their decision. Two individuals $i \in \{A; B\}$ have to decide whether to invest ($x^i = 1$) or not invest ($x^i = 0$) in a particular asset. Each individual observes a private signal θ^i which is independently and uniformly distributed with $\theta^i \in [-1, 1]$. The return on investment for both individuals is $\theta^A + \theta^B$ and they only invest if $\theta^A + \theta^B > 0$. Time is divided into two periods and individuals can invest in either period. If individual A would be forced to move in the first period, his set of information is limited to $\{\theta^A\}$ and thus, since $E[\theta^B] = 0$, he only invests if $\theta^A > 0$. Individual B is told to make his decision in the second period. He is in a better position since he has an information set of $\{\theta^B, x^A\}$. Consequently, he only invests if $\theta^B + E[\theta^A] > 0$. If individual A invested, then $E[\theta^A|\theta^A > 0] = \frac{1}{2}$ and individual B invests if $\theta^B > -\frac{1}{2}$. On the other hand, if individual A did not invest, $E[\theta^A|\theta^A < 0] = -\frac{1}{2}$ and individual B only invests if $\theta^B > \frac{1}{2}$.

Now, individuals are given the right to choose the timing of their action. An individual delaying his decision has to bear waiting costs in form of a common discount factor δ with $0 < \delta < 1$. Hence, an individual investing in the second period has an expected return of $\delta\theta^i$. Suppose that individual $-i$ only invests in the first period if $\theta^{-i} > \bar{\theta}$. Consequently, the expected return for individual i, who waits and has observed that individual $-i$ has not invested in the first period, is:

$$\theta^i + \underbrace{E\left[\theta^{-i}|\theta^{-i} < \overline{\theta}\right]}_{<0} \tag{38}$$

The value of delay equals the expected loss individual i avoids by observing the other individual's decision not to invest. This occurs with probability $P[\theta^{-i} < \overline{\theta}]$. For an individual with signal $\overline{\theta}$ who is indifferent between investing in the first period and delaying, the costs of delaying equal the benefit of delaying:

$$(1-\delta)\,\overline{\theta} = -\delta P\left[\theta^i < \overline{\theta}\right]\left(\overline{\theta} + E\left[\theta^i|\theta^i < \overline{\theta}\right]\right) \tag{39}$$

As Gale shows, there is a single equilibrium value $\overline{\theta} > 0$ which satisfies equation (39) (Gale (1996), 623). As a result, an individual who waits and does not invest in period one, only invests in period two if the other individual has already invested. And even if both individuals observe a signal $\theta > 0$, they will choose not to invest if their signal is below $\overline{\theta}$.

If an influencer, who has perfect knowledge with respect to individuals' discount factor δ, convinces individual i to make the investment independent of his private signal θ^i by providing him with an incentive of

$$b^i = \overline{\theta} + \epsilon \tag{40}$$

Individual $-i$, having observed the decision of individual i, assumes that $\theta_i > \overline{\theta}$ and, facing an expected payoff of $\theta^{-i} + E\left[\theta^i|\theta^i > \overline{\theta}\right]$, also invests despite a negative private signal as long as $\theta_{-i} > -\frac{1}{2}$.

Even in a decision context with more than two individuals, with high probability, the decisions of individuals A and B will be copied by all remaining individuals since expected payoff increases with every positive investment decision. Hence, in a context of endogenous ordering an influencer is able to seed cascade behavior by convincing individuals to make their decision early, and turning those individuals into fashion leaders whose decision is quickly imitated by other individuals.

4 Cascade Seeding and Stardom

The first paper of this dissertation outlined the relevance of informational cascades as an explanation for superstar phenomena. As has been pointed out in this paper, cascades are especially relevant in markets where consumers face significant uncertainty with regard to the quality of the respective goods between which they are able to choose. And the empirical findings with respect to cascade-based stardom in the markets for fine art, which have been presented in the second paper of this dissertation, provide a strong indication that cascade behavior has a significant influence on which artists become superstars.

Given the relevance of informational cascades as a mechanism behind the creation of superstars, it is evident that cascade seeding offers significant potential to producers seeking to become superstars. As long as the quality of the goods they offer is not fully revealed to consumers, they can exploit this lack of transparency and manipulate consumer behavior to their benefit. The model presented in section (2) can easily be extended to reflect a decision context in which consumers have to choose between two or more goods offered by different producers (Bikhchandani, Hirshleifer and Welch (1998), 159). Once the public information with regard to one particular good has become so informative that it dominates individuals' private information, a cascade emerges and the producer of this good is quickly turned into a superstar dominating the market. And the size of the market is defined by the number of consumers m.

One important implication of a "multi-producer environment" in the context of cascade seeding is the inherent competition between producers. Of course, every producer would like see consumers choose the good he is offering. It is thus likely that in an economy of competing producers more than one influencer seeks to manipulate individual decision making in order to maximize his payoff. Assume a simple economy similar to the one described in section (2) in which six identical consumers have to choose between two goods: One good offered by producer X and the other good offered by producer Y. Every individual observes a private signal indicating which of the two goods is of higher quality, and thus results in a higher payoff when being consumed. The consumption of a high good yields a payoff of 1 whereas consuming a low quality good results in a payoff of 0. The costs related to consuming either good are $c = \frac{1}{2}$. The informational setting is identical to the setting described in section (2). It is assumed that producers have perfect information about the quality of their as well as their competitor's good. Both producers seek to maximize their payoff by providing private incentives to consumers. There are two possible scenarios with regard to the true quality of the goods offered by X and Y: Either, one good is of high quality while the other good is of low quality, or both goods are of the same quality.

If X and Y are homogeneous producers and therefore either provide both a high quality good or both a low quality good, then the informational setup of the model has to be changed. Because in this case no good is objectively better than the other, it is assumed that consumers observe both signals with equal probability $\frac{1}{2}$. Despite the fact that both goods are of equal quality, it is assumed that consumers believe that $p \in (\frac{1}{2}, 1)$ and therefore that their private information is somehow informative. Consequently, in this scenario p corresponds to a subjective belief with regard to the quality of the signal instead of an objective signal distribution. Similar to how Rohner, Winestein and Frey (2006, 8) argue, p could be perceived as a "prejudice" of consumers with regard to which of the two options is more favorable.

In period $t = 3$, both producers assess whether following an active strategy and therefore providing incentives to consumers number five and number six is the payoff maximizing option or whether a passive strategy should be followed. In this period, X and Y face the following payoffs:

		Y	
		active	*passive*
X	*active*	0 , 0	$1 - 2b^*$, 0
	passive	0 , $1 - 2b^*$	$\frac{1}{2}$, $\frac{1}{2}$

If both producers opt for providing incentives, then they both have an expected payoff of zero. Because if X knows that Y provides an incentive of $b = b^*$ to each consumer, then he will offer incentives which are slightly higher than b^* in order to convince consumers to choose the good he is offering. Producer Y knows this and thus increases his incentives as well. The result of this "incentive competition" is similar in structure to a first-prize all-pay auction. In this type of auction, every contestant submits a bid for the item being sold, and the contestant with the highest bid receives the item. In contrast to a classical first-prize auction, contestants participating in all-pay auctions have to pay their bid independent of whether their bid is the winning ticket or not.[5] In this type of auction, there is no equilibrium in pure strategies and contestants' mutually optimal replies result in Nash-equilibria in mixed strategies instead. Following the findings of Hillman and Riley (1989), who were the first to study equilibria of all-pay auctions with two bidders, this situation in which both producers provide incentives has a unique and symmetric Nash-equilibrium in mixed-strategies in which both producers have an expected payoff of zero. Consequently, period $t = 3$ has two Nash-equilibria in pure strategies: If $\frac{1}{2} < p < p^*$ with $p^* = \frac{3}{4}$, then both producers provide incentives and therefore have an expected payoff of zero. And if $p^* < p < 1$, then X and Y do not intervene. In this case, they both have an expected payoff of $E[\hat{\Pi}^p] = \frac{1}{2}$. In the second period, given that $\frac{1}{2} < p < p^*$, the payoff structure is

		Y: *active*	Y: *passive*
X	*active*	0 , 0	$2 - 2b^*$, 0
	passive	0 , $2 - 2b^*$	$\frac{7}{8}$, $\frac{7}{8}$

In this case, both producers choose to provide incentives and therefore have an expected payoff of zero. If $p^* < p < 1$ then X and Y face the following payoffs:

		Y: *active*	Y: *passive*
X	*active*	0 , 0	$2 - 2b^*$, 0
	passive	0 , $2 - 2b^*$	1 , 1

The outcome of this game is an equilibrium in which both producers once again follow an active strategy and receive an expected payoff of zero. And in the first period, as the following payoff matrix indicates, X and Y also have an expected payoff of zero:

		Y: *active*	Y: *passive*
X	*active*	0 , 0	$3 - 2b^*$, 0
	passive	0 , $3 - 2b^*$	$\frac{5}{4}$, $\frac{5}{4}$

[5] All-pay auctions have gained popularity as theoretical fundament for the assessment of competitive market settings such as R&D races, political campaigns, or lobbying activities.

Once again, providing incentives is the dominant strategy. Hence, in the specific case of six consumers both producers follow an active strategy in the first period of the decision sequence for all $p \in \left(\frac{1}{2}, 1\right)$, and thus have an expected payoff of zero. And this equilibrium applies to all decision sequences with $m > 2$ because not providing incentives will always be a weakly dominated strategy.

In conclusion, in an economy in which two goods of equal quality are offered, producers are forced into an incentive competition. This competition results in a pareto-inferior Nash-equilibrium in pure strategies in which both producers have an expected payoff of zero for all $p \in \left(\frac{1}{2}, 1\right)$. This equilibrium emerges even though both producers would have a payoff of $E[\hat{\Pi}] > 0$ if they reach an agreement to refrain from any manipulation. However, this agreement would not be self-reinforcing since every producer would have an interest to deviate in order to increase his individual payoff.

With regard to an economy in which two goods of heterogeneous quality are offered, assume that X is the producer of the high quality good. Consequently, the respective payoffs of following an active or a passive strategy in the third period are

		Y	
		active	*passive*
X	*active*	$0\ ,\ 0$	$1 - 2b^*\ ,\ 0$
	passive	$0\ ,\ 1 - 2b^*$	$p\ ,\ 1 - p$

If both producers follow an active strategy, they both receive an expected payoff of zero. Despite the fact that X offers the high quality good, both producers play a mixed strategy and provide incentives on the same interval. If $\frac{1}{2} < p < p^*$ with $p^* = \frac{2}{3}$, the outcome of this game is a unique Nash-equilibrium in pure strategies in which both parties intervene and thus have an expected payoff of zero. If $p^* < p < 1$, providing incentives is a weakly dominated strategy for X and therefore this period has a unique Nash-equilibrium in pure strategies in which Y follows an active strategy and X passively observes the consumers' decisions. Consequently, despite the fact that X is the producer offering the high quality good, he leaves the playing field to Y and thus receives a payoff of zero.

In the second period, given that $\frac{1}{2} < p < p^*$, the two producers face the following payoffs:

		Y *active*	*passive*
X	*active*	$0\ ,\ 0$	$2-2b^*\ ,\ 0$
	passive	$0\ ,\ 2-2b^*$	$p\ ,\ 1-p$

Hence, providing incentives is a dominant strategy for both parties and therefore both have an expected payoff of zero. The second case of $p^* < p < 1$ results in the following payoff structure:

		Y *active*	*passive*
X	*active*	$0\ ,\ 0$	$2-2b^*\ ,\ 0$
	passive	$0\ ,\ 2-2b^*$	$p\ ,\ 2-\frac{1}{2}p(p+4b^*(1-p)+3)$

Once again, there is a unique Nash-equilibrium in pure strategies in which both producers provide incentives. And the payoffs in the first period lead to similar results:

		Y *active*	*passive*
X	*active*	$0\ ,\ 0$	$3-2b^*\ ,\ 0$
	passive	$0\ ,\ 3-2b^*$	$p\ ,\ 1-p$

Both producers respond to this decision situation by providing incentives and therefore try to seed a cascade in the first period of the decision sequence. In conclusion, similar to the economy of two homogeneous producers, this equilibrium applies to all decision sequences with $m > 2$ and for all $p \in (\frac{1}{2}, 1)$.

The application of cascade seeding in a context where two producers desire to become superstars has revealed that the result of this competitive setting is independent of whether both producers offer high quality goods, low quality goods, or goods of heterogeneous quality. If the producers are able to alter the outcome of collective consumer decision, then they both choose to engage in an incentive competition that leaves them with an expected payoff of zero. One could assume that, because this game is played over multiple periods, producers could reach an agreement which would lead to a higher payoff for both of them. However, since every producer has the possibility of winning the entire market in just one period, any given producer would never stick to such an agreement. Thus, a cooperation based solution cannot be reached.

5 Excursus: Public Influencers

Informational cascades are often perceived as cause for informational inefficiencies and undesirable outcomes of decision processes. A great number of historical examples, such as the Dutch tulip mania in the 17th century or the sudden resistance to MMR vaccinations in the beginning of the 21st century, prove that cascade behavior often has a negative effect on collective welfare. But as Bikhchandani, Hirshleifer and Welch (1992, 1002) point out, informational cascades can also help to bring about beneficial change. This applies for example to the emergence of movements that lead to political reforms or to the diffusion of new technological developments. Such developments are often initiated by change agents whose behavior is quickly copied by other individuals. If cascade behavior can have a positive effect on collective welfare, it follows that cascades can not only be seeded to increase the profit of individual influencers such as artists aspiring to become superstars, but could also be actively triggered to the benefit of the public. For instance, cascades could be seeded by public institutions that aim at influencing the outcome of social decision processes. It is therefore worthwhile to analyze whether cascade seeding is in fact an advantageous tool for public institutions that seek to support individuals in making the right choice.

The following example is based on the model outlined in section (2). In this example, the role of the influencer is played by a public institution which aims at maximizing overall welfare, and the decision which individuals face is whether to buy a certain vitamin supplement ("adopt") or to ignore this product ("reject"). The consumption of this product creates individual costs of $c = \frac{1}{2}$. Since considerable advertisement has been made to praise the product's positive health effects, individuals observe a high signal with probability p and a low signal with probability $1 - p$. They are therefore inclined towards consuming the product which they believe results in a payoff of $V = 1$. The institution however knows that the product has no beneficial health effects ($V = 0$), and therefore aims at convincing individuals to reject.

The funds needed to finance the incentives are raised through tax τ which every individual has to pay to the institution. With α denoting the expected number of buyers, the expected impact of this collective decision on individual welfare W_i is

$$E[\Delta W_i] = -\left(\tau + \frac{\alpha}{2m}\right) \tag{41}$$

In the first scenario, the institution does not intervene. In this case, following equation (13), the expected number of buyers is

$$\alpha^h = \frac{m}{2}\left(p - p^2\right)^{\frac{m}{2}} + \sum_{i=0}^{\frac{m}{2}-1}\left(p - p^2\right)^i \left(\frac{m}{2}(p + p^2) + (1 - 2p)i\right) \tag{42}$$

And the expected effect on individual welfare is

$$E[\Delta W_i] = -\frac{\alpha^h}{2m} \tag{43}$$

In the second scenario, the institution intervenes by providing incentives. In this case, incentives could be provided in form of information material that is distributed to individuals. It is assumed that an individual, after having received an incentive, observes a low signal with probability p and a high signal with probability $1 - p$. Consequently, it is more likely that a down cascade develops and convinces individuals to make the right decision. If incentives are given to all m individuals, then the expected number of buyers follows equation (24):

$$\alpha^l = \frac{m}{2}\left(p - p^2\right)^{\frac{m}{2}} + \sum_{i=0}^{\frac{m}{2}-1}\left(p - p^2\right)^i \left((1 - p)\left(1 - \frac{1}{2}p\right)m + (2p - 1)i\right) \tag{44}$$

In this scenario, the collective decision has an impact on individual welfare of

$$E[\Delta W_i] = -\left(\tau + \frac{\alpha^l}{2m}\right) \tag{45}$$

If the public institution defines tax $\tau = \tau^*$ so that the expected welfare effect in a "laissez-faire" regime equals the effect in a regime in which the institution intervenes then

$$\begin{aligned} \frac{\alpha^h}{2m} &= \tau^* + \frac{\alpha^l}{2m} \\ \tau^* &= \frac{\alpha^h - \alpha^l}{2m} \end{aligned} \tag{46}$$

It follows that the intervention of the public institution has a positive impact on individual welfare as long as $\tau < \frac{\alpha^h - \alpha^l}{2m}$. Assume that $m = 100$ and $p = 0.75$. In this case, if $\tau < \tau^*$ with $\tau^* \approx 0.3062$, then individuals benefit from the intervention of a public influencer. Even though the collective decision still negatively affects welfare, by encouraging individuals to reject and thereby supporting the formation of a down cascade, the institution is able to reduce this negative effect. This brief example shows that a public institution can increase overall welfare by actively seeding or at least encouraging cascades which induce individuals to make the right decision.

6 Conclusion

Building an influencer into the theoretical framework of informational cascades has revealed that influencers can effectively manipulate collective decision processes and intentionally create herding behavior by providing private incentives to selected individuals. Whether cascade seeding pays off depends on the length of the decision sequence, the quality of individuals' private information, the true value of the underlying state, and on whether multiple influencers engage in cascade seeding activities.

In an economy with only one influencer, the payoff maximizing strategy significantly depends on whether this influencer tries to convince individuals to make an unfavorable or a favorable decision. In the first case, he maximizes his payoff by seeding a cascade in the first period of the decision sequence independent of the length of the sequence and the quality of private signals. In the latter case, whether a cascade should be seeded or not, depends on how well individuals are informed as well as the length of the decision sequence. The longer the sequence the higher the equilibrium value for the level of signal quality below which the influencer maximizes his payoff by intervening. If the influencer faces a very large group of decision makers, then this equilibrium value is close to one.

Given the empirical relevance of informational cascades with regard to superstar phenomena, cascade seeding seems at first glance to be an effective tool to create stardom. However, as this paper has shown by assessing an economy with competing producers who try to convince consumers to buy their goods, cascade seeding does not necessarily pay off. As soon as the group of consumers comprises more than two individuals, these producers engage in an incentive competition which leaves both of them empty handed. Interestingly, this result is independent of whether both producers offer a low quality good, a high quality good, or whether they offer goods of differing qualities.

This paper has also presented several extensions of the basic model and explained how these extensions impact cascade seeding strategies. One path for further extending the model which this paper has spared is particularly interesting. As herding is often caused by cascade behavior in combination with other herding mechanisms, it would be interesting to analyze cascade seeding when individuals' decisions are affected by cascades as well as other herding phenomena. The first paper of this dissertation has pointed out that besides informational externalities, individual decision making behavior is often affected by positive payoff externalities, particularly in decision environments that are subject to superstar phenomena. Therefore, it would be interesting to account for positive payoff externalities in an extended cascade seeding model, and analyze how these externalities impact an influencer's optimum strategies. Moreover, the model presented in this paper could be modified to a multi-period model in which decision sequences are repeated. Such an analysis would show which strategy an influencer should follow if payoffs are revealed before decision makers decide again.

The findings of this paper can be tested empirically in all contexts in which informational cascades are expected to impact the decision behavior of individuals. De Vany and Walls (1996) analyze the distribution of box office revenues and stress the relevance of informational cascades as explanation for herding behavior among motion picture audiences. In this context, advertising campaigns by companies, which are responsible for the distribution of a motion picture, can be interpreted as attempt to intentionally create cascade behavior among movie spectators. As a consequence, cascade seeding can be studied based on examining distributors' advertising budgets relative to total costs, as well as the timing of advertising campaigns. With respect to such an empirical analysis, different levels of decision uncertainty from the perspective of spectators could be modeled based on the popularity of the respective actors which a movie stars.[6] Following the theoretical findings of this paper, and given that distributors seek to maximize their profit, one would expect that movies staring unfamiliar actors have averagely higher advertising bud-

[6]Within such an empirical analysis, the popularity of an actor could be based on the ranking of highest-earning actors which is published annually by the Forbes magazine.

gets relative to total costs, and that, compared to movies with more popular actors, advertising campaigns are initiated earlier before the movie is released in theaters.

In order to further validate the findings of this paper, the model could also be tested experimentally in a laboratory environment. Various studies have already analyzed cascade behavior in classroom settings.[7] The experimental setups of these studies could easily be extended to account for an influencer who provides incentives to the participants of the experiment. In such a setup, the role of the influencer would be randomly assigned to one of the participants. Next, the participants would make their decision, and the influencer would be given the option to intervene right before every participant would make his decision. The results of such an experiment could reveal how individuals deal with the fact that an influencer is present and that decisions by other individuals are potentially manipulated.

Informational cascades are often one-sidedly viewed as cause for informational inefficiencies, and unfavorable results produced by incorrect cascades. As the excursus presented in section (5) shows, cascade seeding is not only an effective tool for influencers seeking the maximization of their own private profit, but also for public institutions aiming at improving overall welfare. By intentionally seeding or encouraging certain cascade behavior, public institutions can guide collective decision processes and convince individuals to make the right decision. It would be interesting to gain more insight into the potential of cascade seeding as a tool for creating “positive herding behavior”.

[7] For studies of cascade behavior in a laboratory environment see e.g. Anderson and Holt (1997), Huck and Oechssler (2000), Kübler and Weizsäcker (2004), Çelen and Kariv (2004) or Spiwoks, Bizer and Hein (2008).

A Appendix

A.1 Illustrative Example

To illustrate the findings with respect to the influencer's optimum strategy, let's go back to the wine example outlined in section (2) and analyze two scenarios with different signal qualities. In the first scenario, the winemaker faces critics with rather scarce wine knowledge who publish their reviews in local newspapers. To reflect this low level of decision specific knowledge, signal quality is set to $p = 0.6$ for all critics. The winemaker knows that the wine he is producing is of high quality. Hence, the probability that a critic, who only relies on his own private information, writes a positive review is 60 percent.

In the last period of the decision sequence, intervening by providing incentives to critic number five and critic number six results in a payoff of $E[\hat{\Pi}^a] = 1 - 2b^* = 0.8 - \epsilon$ since $b^* = 0.6 - 0.5 + \epsilon = 0.10 + \epsilon$ (for simplicity the term ϵ is omitted in the remainder of the example). If the winemaker decides not to intervene, he has an expected payoff of $E[\hat{\Pi}^p] = 0.6$. Hence, in this period providing incentives is the payoff maximizing strategy.

When the winemaker assesses his options with regard to the second period, he knows that he will provide incentives to the last two critics given that no cascade develops in the second period. Hence, following a passive strategy in this period of the decision sequence would lead to an expected payoff of $E[\hat{\Pi}^p] = 1.272$. Seeding a cascade in this period yields a payoff of $E[\hat{\Pi}^a] = 1.8$. Hence, the winemaker is better off if he initiates cascade behavior in this period.

In the first period of the decision sequence, the winemaker is in a situation that is similar to period $t = 2$. He knows that if cascade behavior does not emerge in the first period, he will seed a cascade in the following period. Hence, he can either passively observe critics number one and two, or he can start the cascade in this period instead of waiting until the second period. The first option results in an expected payoff of $E[\hat{\Pi}^p] \approx 1.99$ whereas the second option leads to a payoff of $E[\hat{\Pi}^a] = 2.8$. Consequently, the winemaker maximizes his payoff by seeding a cascade in the first period, and thereby convincing all six critics to write positive reviews.

In the second scenario, the winemaker faces a group of wine critics that are better informed than their colleagues of the first scenario, and signal quality is therefore set to $p = 0.75$. Because critics have more precise private information, the winemaker has to provide a bigger incentive in order to "buy" a positive review. This time the required incentive is $b^* = 0.25$. Consequently, an active strategy in period $t = 3$ results in a payoff of $E[\hat{\Pi}^a] = 0.5$. On the other hand, the winemaker receives an expected payoff of $E[\hat{\Pi}^p] = 0.75$ if he does not intervene. In conclusion, the passive strategy is the payoff maximizing option in the third period.

In period $t = 2$, the winemaker is once again better off if he does not provide incentives since seeding cascade behavior results in a payoff of $E[\hat{\Pi}^a] = 1.5$, and not intervening yields an expected payoff of $E[\hat{\Pi}^p] \approx 1.55$. Hence, in the last two periods of the decision sequence the winemaker should simply leave the critics' decisions to chance.

The winemaker now weighs his options with regard to the two critics at the beginning of the decision sequence. If he provides incentives to these two critics, he receives a payoff of $E[\hat{\Pi}^a] = 2.5$. If he decides to follow the same strategy as in period number two and period number three, then his payoff is $E[\hat{\Pi}^p] \approx 2.35$. As a result, the winemaker maximizes his payoff by starting a cascade. In conclusion, both scenarios have similar outcomes: The first two critics write positive reviews and thus initiate an informational cascade which convinces all remaining critics to also write positive reviews. However, as the example showed, the optimum strategy depends on signal quality p as well as group size m. If the winemaker would have faced only four critics in the second scenario, then he would have refrained from providing any incentives.

A.2 Expected Number of Adopt Decisions

The expected number of adopt decisions depends on: 1) Whether and when an informational cascade forms and 2) given that a cascade forms, whether this cascade is an up or a down cascade. If the cascade is an up cascade it follows that

UP cascade starts in period	$t = 1$	$t = 2$	$t = 3$	...	$t = \frac{m}{2}$
Number of adopt decisions	m	$m - 1$	$m - 2$	...	$\frac{m}{2} + 1$

And if the cascade is a down cascade it follows that

DOWN cascade starts in period	$t=1$	$t=2$	$t=3$	...	$t=\frac{m}{2}$
Number of adopt decisions	0	1	2	...	$\frac{m}{2}-1$

Given that $V=v^h$, an up cascade starts with probability $\frac{1}{2}p(1+p)$ and a down cascade with probability $(1-p)\left(1-\frac{1}{2}p\right)$ in any period $t=1,...,\frac{m}{2}$. However, this requires that no cascade has started before that period. The probability that no cascade starts before period $t=2$ is $(p-p^2)$. The probability that no cascade has emerged before period $t=3$ is $(p-p^2)^2$ and so forth. Hence, the number of expected adopt decisions given that cascade behavior emerges is

$$\begin{aligned}&\sum_{i=0}^{\frac{m}{2}-1}\left(p-p^2\right)^i\left(\frac{1}{2}p(1+p)(m-i)+(1-p)\left(1-\frac{1}{2}p\right)i\right)\\ =&\sum_{i=0}^{\frac{m}{2}-1}\left(p-p^2\right)^i\left(\frac{m}{2}\left(p+p^2\right)+i\left(1-2p\right)\right)\end{aligned} \tag{47}$$

What has not been taken into account so far is the scenario that no cascade develops at all which occurs with probability $(p-p^2)^{\frac{m}{2}}$. In this case, there is an equal number of adopt and reject decisions. Adding this case to equation (47) results in

$$\alpha^h=\frac{m}{2}\left(p-p^2\right)^{\frac{m}{2}}+\sum_{i=0}^{\frac{m}{2}-1}\left(p-p^2\right)^i\left(\frac{m}{2}\left(p+p^2\right)+i\left(1-2p\right)\right) \tag{48}$$

The approach with respect to determining the expected number of adopt decisions given that $V=v^l$ is similar. However, the respective probabilities for an up cascade and a down cascade have to be adjusted since, in this case, an up cascade emerges with probability $(1-p)\left(1-\frac{1}{2}p\right)$ and a down cascade with probability $\frac{1}{2}p(1+p)$ in any period $t=1,...,\frac{m}{2}$.

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Concluding Remarks

As Adler (2006) points out, the continuous globalization of economic activities further increases the relevance of superstar phenomena and the importance of being able to understand the mechanics behind the creation of superstars. According to Adler, "a global culture, with a global set of superstars, is replacing local cultures with local stars, and it is therefore important to know what this means for consumers, artists and art" (Adler (2006), 11).

This dissertation provides a valuable extension of the explanatory basis for understanding how superstars emerge. First, it outlines the relevance of informational cascades in the creation of superstars and presents an extended cascade model which explains cascade-based stardom that is stable and less sensitive to informational shocks. Second, it examines the true relevance of informational cascades as explanation for stardom based on empirical data from the markets for fine art. Third, it provides a theoretical understanding of how cascades can intentionally be seeded by an influencer seeking to become a superstar, and shows which strategy the influencer should follow in order to maximize his payoff. The arguments and results presented by this dissertation are of particular relevance since stardom is explained in an environment that is subject to decision uncertainty from the perspective of consumers, which is present in most markets.

What has only been marginally covered by this dissertation is the welfare perspective of superstar phenomena. As the discussion on stardom has revealed, the answer to how superstars emerge is context specific. More understanding is needed with regard to the welfare effects of the respective superstar phenomena and to what extent these effects differ. The increasing relevance of stardom implies a heightened importance of determining and evaluating alternative market designs which ensure that talent is optimally employed in order to maximize overall welfare.

Analyzing cascade-based stardom has once again revealed the difficult nature of investigating the true relevance of informational cascades as cause for herding behavior. This dissertation has further substantiated findings of earlier research that herding is often caused by multiple herding mechanisms and that it is difficult to determine how much cascades actually contribute to behavioral uniformity. Thus, future empirical research is needed to investigate interlinkages between different herding mechanisms and examine how herding, that is caused by multiple mechanisms, impacts superstar phenomena.

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