Influencers: The Power of Comments*

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Abstract

Many customers choose products based on information from social media influencers. Companies can pay these influencers to promote their products. We develop a model in which customers read an influencer's sponsored post for a mix of entertainment and product information, and those who purchase the product can leave comments for future customers. We derive conditions in which a large celebrity influencer endorses all products, whereas a micro-influencer adopts a policy of endorsing only high quality products. In equilibrium, the micro-influencer screens for high quality products so his followers do not waste time reading informative comments about low quality products. By contrast, the celebrity influencer attracts so many uninformative comments his followers do not use his comments as a source of product information, and the value of his endorsement arises solely from generating product awareness.

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1 Introduction

Firms can pay social media influencers to endorse their products on blogs, Instagram, and other social media websites. Although regulators require influencers to disclose when they are paid for an endorsement, advertisers have nonetheless found that these endorsement deals can generate a significant increase in product purchases (Nielsen 2016, 2020). For example, each year clothing retailer Nordstrom partners with dozens of social media influencers to promote its summer Anniversary Sale, which *AdWeek* calls "the Super Bowl for fashion influencers," an event that causes stockouts of many popular clothing items and rivals the December holidays in terms of sales volume for the retailer (Pearl 2018). Such influencer marketing campaigns represent a rapidly growing share of firms' advertising budgets. Firms spent about $16.4 billion on influencer marketing in 2022, which is expected to increase to $21.1 billion in 2023 (Influencer Marketing Hub 2023). These endorsement deals also generate significant income for top influencers. Soccer star Cristiano Ronaldo earns about $47 million from sponsored Instagram posts each year, which is greater than his annual salary for playing soccer (McCarthy 2019).

Influencers can be broadly divided into two categories. Celebrity influencers with high entertainment value such as sports, music, and reality television stars often have millions of followers on social media websites like Instagram. By contrast, micro-influencers have fewer than one million followers, and in many cases have only several thousand followers.

Influencer marketing firms like TapInfluence and ApexDrop help arrange sponsorship deals with influencers. These firms claim that the smaller micro-influencers have greater authenticity, meaning they only endorse products they truly use and enjoy (Cruz 2018). There is widespread anecdotal evidence from advertising managers that micro-influencers typically refuse paid endorsement deals if they believe the product is a poor fit for their followers (Carufel 2021).[1] By contrast, celebrity influencers often

[1] An interior design influencer with 80 thousand followers stated, "When brands approach me, I'd like to know that they respect me, my audience, and what I put out in the world. I can help brands reach my audience authentically and turn that engagement into new relationships, fans, followers, and customers – but it has to resonate with my audience, and I know them best" (Baklanov 2021).

endorse products they do not even use (Nephew 2020).

Another key difference is micro-influencers have greater engagement, meaning their followers are more likely to write comments sharing their own opinions and experiences (Cruz 2018). Popular business articles advise firms that want to advertise with a micro-influencer to read comments by the influencer's followers to determine if they are a good fit for the advertiser's product (Bowman 2018; Sortino 2022). Academic research has also shown that social media followers are more likely to comment on posts by smaller influencers (Bentley et al. 2021), and that such comments contain valuable information about customer needs and opinions (Schweidel and Moe 2014).

Even casual browsing of the Instagram pages of celebrity influencers and micro-influencers reveals striking differences in the types of products they endorse and the comments their followers make. For example, Cristiano Ronaldo, who has over 500 million followers on Instagram, recently made a sponsored post endorsing an Italian online university called eCampus University (Bertacche and Remondini 2019). The overwhelming majority of comments on this post consist only of emojis or short messages expressing support for Ronaldo himself, with no substantive information about the school he is endorsing. As a contrasting example, a micro-influencer with the user name mississippivegan, who has about 150 thousand Instagram followers, recently made a sponsored post in which he developed a recipe for brown rice mixed with Muir Glen tomatoes. Most of the comments on this post provide a description of his followers' own experiences cooking this dish and even suggesting improvements to the recipe. (See Appendix A for screenshots of these posts by Ronaldo and mississippivegan.)

Standard reputation models imply that larger firms make greater effort to protect their brand (e.g., Kreps and Wilson 1982; Diamond 1989; Chu and Chu 1994; Cabral and Hortaçsu 2010). Therefore, it is somewhat surprising that smaller influencers, who have relatively few followers, seem to be more protective of their brand than celebrity influencers with millions of followers.

This paper develops a formal model that helps explain why smaller influencers are more selective about which types of products they endorse and also generate

more informative comments from their followers. In our model, an influencer who has either high or low entertainment level can endorse a seller's product. The influencer first chooses an endorsement policy, which can involve either endorsing all products or endorsing only a high quality product. The influencer and seller then observe the product's quality level. If product quality is consistent with the influencer's endorsement policy, the seller and influencer bargain over an endorsement fee the seller pays the influencer to write a sponsored post.

A first group of followers read the sponsored post, can purchase the product, and can also leave a comment. Customers who purchase the product leave informative comments that provide both entertainment utility and status utility to commenters, whereas those who read the post purely for entertainment value leave uninformative comments that provide commenters only with entertainment utility. A second group of followers then read the post and can purchase the product, with the key difference that each of these customers can learn whether the product is a good fit for her by reading comments by the first group of customers.

We derive conditions in which a high entertainment influencer endorses all products, whereas a low entertainment influencer endorses only high quality products. Intuitively, a sponsored post by a high entertainment influencer leads to so many uninformative comments that the only value from this sponsorship results from generating product awareness with a large number of potential customers. For such an influencer, expected profits are maximized by endorsing any product with an expected value to customers that exceeds its marginal cost. As long as the expected surplus generated by selling low quality products is positive, a high entertainment influencer endorses all products. By contrast, a sponsored post by a low entertainment influencer generates a higher percentage of informative comments, allowing customers from the second group to learn whether the product is a good fit for them before they make purchase decisions. For such an influencer, endorsing low quality products generates higher reading costs for followers without generating many additional product sales because informative comments usually reveal that the product is a poor fit for his followers. Therefore, a low entertainment influencer may want to avoid endorsing low

quality products, so his followers do not waste time reading comments about products that are unlikely to be a good fit. Thus, our model predicts that celebrity influencers may have an endorsement policy that varies depending on the product category being endorsed, whereas micro-influencers endorse only high quality products for all categories unless their followers have very low reading cost.

We also present four model extensions. First, we derive conditions in which reputation concerns compel an influencer not to deviate from his policy of endorsing only high quality products. Second, we show that a micro-influencer may want to specialize in endorsing products for which he has the expertise to identify quality levels, whereas a celebrity influencer is willing to endorse products outside of his expertise. Third, we derive conditions in which an influencer deletes uninformative comments from his post to make it easier for followers to find informative comments. Fourth, we develop a more detailed model of the costs and benefits of commenting, and we adapt our results to this model extension.

Section 2 discusses related literature. Section 3 presents the model set-up. Section 4 presents results. Section 5 concludes. Appendix A has examples of sponsored Instagram posts. Appendix B contains the model extensions. Appendix C presents proofs of all formal results.

2 Related Literature

Game theory research on influencer marketing has studied the optimal product variety when influencers provide product information (Kuksov and Liao 2019), the optimal affiliation between a firm and influencers (Pei and Mayzlin 2021), how firms compete for influencers considering the overlap in the influencers' reach (Katona 2020), how influencers compete with each other for paid sponsorships (Fainmesser and Galeotti 2021), and differences between influencer marketing and targeted advertising (Berman et al. 2023). Our model focuses instead on how an influencer's entertainment level affects the informativeness of their comment section and which products they endorse.

Previous research has used a variety of methods to study why consumers write online comments or product reviews. Toubia and Stephen (2013) conduct a field experiment to compare intrinsic motivation with image-related utility for Twitter users. Brodie et al. (2013) find in an online ethnographic study that creating content or being part of a community increases satisfaction for some customers. He et al. (2018) conduct experiments showing that expressing a like or dislike increases task enjoyment. Iyer and Katona (2016) and Campbell et al. (2017) build formal models in which customers derive status-based utility from social communication. Based on this earlier research, our model explicitly includes both intrinsic utility and status utility from commenting, and we show how the resulting comments by followers affect an influencer's optimal endorsement policy.

Our paper has a conceptual connection with research by Wernerfelt (1994, 1996) on efficient provision of products and information. In our model, celebrity influencers generate mass awareness but do not provide information about product fit, which results in the seller incurring production costs even for customers for whom the product is a poor fit. By contrast, micro-influencers generate information about product fit, which allows the seller to avoid unnecessary production costs but also results in a cost of followers reading comments. Thus, we show the optimal endorsement policy for a celebrity influencer depends on product production cost, whereas the endorsement policy for a micro-influencer depends on followers' reading costs.

Previous research has developed models in which a firm can affect the informativeness of online comments, either by writing messages pretending to be customers reviewing their product (Mayzlin 2006), or by allowing product information created by the consumers to be posted on the seller's website (Chen and Xie 2008). Our paper includes a model extension in which the influencer can increase the informativeness of their comment section by deleting some uninformative comments, and we compare the incentives for comment deletion by large versus small influencers.

Recent empirical evidence shows that followers' engagement with an influencer depends on the size of the influencer's reach. Followers click the like button on posts

by large and small influencers at similar rates, but have a higher rate of commenting on posts by smaller influencers, suggesting deeper engagement with smaller influencers (Bentley et al. 2021). Followers are also more likely to perceive a post by a larger influencer as an attempt to persuade rather than an honest attempt to share product knowledge (Chu et al. 2021). However, more entertaining content can increase the effectiveness of influencer ad campaigns for some types of products (Yang et al. 2021). Our paper proposes a formal model to explain why a large celebrity influencer has many followers and can help build product awareness (due to a high entertainment level), whereas a small micro-influencer is more informative as followers of small influencers post comments that help future consumers in their search for product information.

Sponsored influencer posts, as a form of advertising, are particularly susceptible to deceptive practices. Game theory models have investigated how consumers respond to deceptive advertising (Wu and Geylani 2020) and how publishers and advertisers respond to fraudulent online ad impressions (Choi and Sayedi 2023). Conceptual research has identified both influencers and followers as potentially deceptive in sharing product information (Nistor et al. 2018). Yalcin et al. (2020) present anecdotal evidence that the role of influencers in sharing information about product attributes ranges from pure advertising to education of followers. Cain et al. (2010) present experimental evidence that consumer do not sufficiently discount the content of a recommendation even when they know the post or ad is sponsored. Our model implies one reason a consumer may trust a sponsored influencer post is that she can read informative comments by other followers to determine whether the product is truly a good fit for her. We show that larger influencers are in a sense less trustworthy because they endorse lower quality products. However, there is no explicit deception in our model because customers are aware of the influencer's endorsement policy.

Our paper is tangentially related to the large literature on advertising as a signal of product qualtiy (e.g., Milgrom and Roberts 1986; Zhao 2000; Mayzlin and Shin 2011; Miklós-Thal and Zhang 2013; Joshi and Musalem 2021). We show that, in equilibrium, a less entertaining influencer endorses products with higher average

quality. However, there is no quality signaling in our model because we focus on the influencer's choice of an endorsement policy, rather than the firm's choice of an influencer.

3 Model

An influencer can make a social media post endorsing a seller's product. His followers can read and comment on this post and can purchase the product.

To begin the game, the influencer chooses an endorsement policy. He can choose either to endorse all product types, or to endorse only a high quality product. We assume this choice of endorsement policy is publicly observed and binding. We later present a model extension in which reputation concerns compel the influencer not to deviate from his chosen endorsement policy.

A monopolist sells a product that has high quality with probability α and low quality with probability $1-\alpha$, where $0 < \alpha < 1$. The product meets the needs of a fraction q of potential customers. For a high quality product $q = \overline{q}$, and for a low quality product $q = \underline{q}$, where $0 < \underline{q} < \overline{q} < 1$. Nature chooses product quality. The seller and the influencer observe product quality.[2] The influencer's followers do not directly observe quality. If the product has low quality and the influencer has a policy of only endorsing high quality products, the game ends with zero payoff for all players. Otherwise, the game proceeds to the next stage.

The seller and the influencer bargain over a fixed payment the seller makes to the influencer to endorse the product. We do not explicitly model the bargaining process, although we assume the outcome is a proportional split the expected profits from the endorsement deal. For example, Nash bargaining and some non-cooperative bargaining models result in a proportional split of surplus (Binmore et al. 1986). Because the influencer receives a fixed proportion of expected profits, he sets his

[2] A model extension in the appendix considers the case in which the influencer sometimes cannot observe quality.

endorsement policy to maximize expected profits. After making the fixed endorsement payment, the seller will set prices to maximize profits.

The seller sets the product's initial price. Customers do not yet observe price.

Followers of the influencer then read the influencer's post endorsing the product. Reading the post makes customers aware that the product exists. Customers may know in advance that the company will launch some type of food or some type of clothing, for example, but they do not know the particular type of food or clothing until they read the influencer's post. Reading the post also reveals the product's current price. Customers then have the opportunity to buy the product.

There are two types of customers. There is a total mass M_Z of customers who are not interested in the product and derive zero value from it (these followers may read the influencer's post purely for entertainment value), and a mass M_V who are interested in the product and derive value V from consuming the product if it is a good fit, where $V > 0$. Customers derive zero value from consuming a product that is a poor fit.

These customers arrive in two sequential groups. Those who have time to read the post soon after the influencer writes it are part of the first group, whereas those who have time to read the post at a later date (after the first group has already made product purchases) are part of the second group. Similar to previous theoretical research on advertising (e.g, Milgrom and Roberts 1986; Miklós-Thal and Zhang 2013), we allow the firm to adjust the product's price after the initial group of consumers make their purchases. The firm initially sets price P_1, and customers in the first group can purchase at this price. After the first group of customers makes their purchase decisions and comments, the firm can change its price to a different price P_2, and customers in the second group can purchase at this new price. The firm chooses endogenous prices, which we will show are equal to willingness to pay of customers who are interested in the product in each period. This setup is equivalent to allowing the firm to offer a limited-time discount code to encourage the first group of followers to try the product, which is a common feature of Instagram influencer

ads (Chitrakorn 2020; Markerly 2022; Grin 2022).[3]

Each customer has probability β of belonging to the first group of customers who can read the post immediately after the influencer posts, and probability $1 - \beta$ of belonging to the second group who can read the post at a later date, where $0 < \beta < 1$. For example, there is a mass βM_Z of followers who derive zero value from the product in the first group, and a mass $(1 - \beta)M_Z$ of such followers in the second group. We will show that, in equilibrium, followers in both groups receive the same expected utility, so there would be no incentive for a follower from the first group to delay reading the post to join the second group, for example.

Customers in the first group do not learn whether the product is a good fit for them until after they have purchased it. Customers who purchase the product can then make an informative comment describing their experience with the product, for example, confirming whether the product performs as promised on a particular vertical attribute, or providing additional information about a horizontal attribute of the product. If they do not purchase the product, they can write an uninformative comment such as an emoji or general message of support for the influencer.

Writing a comment is an endogenous decision by utility-maximizing followers. Previous research has shown customers write comments both for the intrinsic utility from commenting and for the status utility from having others read a comment (Toubia and Stephen 2013; He et al. 2018). Our model allows for both types of utility. First, all followers derive intrinsic utility from writing a comment. For modeling parsimony, we do not explicitly model this intrinsic utility or the cost of commenting, although one can think of the variable M_Z as the number of followers who are not interested in the product and for whom the intrinsic utility of commenting exceeds the cost of commenting. In addition, similar to the word-of-mouth model by Campbell et al. (2017), followers who are interested in the product can derive status utility

[3]In principle, we could assume product prices are exogenous and derive similar results. With exogenous prices, quality expectations would affect product demand instead of affecting prices. We could also assume prices are endogenous and fixed across the two periods, in which case quality expectations would affect both price and demand. In all of these cases, equilibrium profits depend on followers' quality expectations given the influencer's endorsement policy.

from writing an informative comment. If a customer in the first group purchases the product and writes an informative comment, she derives status utility S for each customer in the second group who reads her informative comment, where $S > 0$. Before deciding whether to purchase the product, followers anticipate the status utility they will derive from writing an informative comment, and their willingness to pay for the product increases with this expected status utility. The appendix develops a more detailed model of the cost and benefits of commenting and derives conditions in which our model results hold for this alternative model of commenting.

Customers in the second group who read the influencer's post observe the second period price. Second period customers can then read comments, with cost R for reading each comment. Reading an informative comment reveals to a customer whether the product is a good fit for her. Thus, customers in the second group may choose to continue reading comments until they learn whether the product is a good fit before they buy the product.[4]

To summarize, the game timing is as follows:

1. The influencer decides his endorsement policy.

2. Nature chooses the product quality level, which the firm and the influencer observe. The game ends if the influencer's policy is not to endorse products with the given quality level.

3. The firm and the influencer bargain over a fixed payment the firm makes to the influencer to endorse the product.

4. The firm sets the product's first period price.

5. Followers in the first group read the influencer's post. These followers then learn the product's current price, have the option to buy the product, and leave comments.

[4]For simplicity of exposition, we assume there is a continuum of customers of each type, so the first group effectively produces an infinite number of comments, and the probability that the next comment will be informative does not change as a customer in the second group continues reading uninformative comments.

6. The firm sets the product's second period price.

7. Followers in the second group read the influencer's post. These followers learn the product's current price. They can then read comments and have the option to buy the product.

Each customer maximizes her expected utility, with all variables defined such that a customer's marginal utility of wealth is normalized to one. For example, in the first period, if a customer who is interested in the product purchases the product, finds the product is a good fit, and leaves a comment that is read by one second period customer, then her utility is $V - P_1 + S$. Similarly, in the second period, if a customer who is interested in the product reads one comment, purchases the product, finds that the product is a good fit, then her utility is $V - R - P_2$.

The firm and the influencer each maximize their expected profits. Let D_1 and D_2 denote product demand from the first and second group of customers, respectively, and let C denote the product's marginal production cost, where $0 < C < [\alpha\overline{q} + (1 - \alpha)\underline{q}]V$. Total profits are $\pi = (P_1 - C)D_1 + (P_2 - C)D_2$. Recall that the bargaining process leads the firm and influencer to split expected profits proportionally.

Table 1. Model notation

α	Probability that the product has high quality
$\underline{q}, \overline{q}$	Probability that low and high quality product meets customer i's needs
P_1	Price of the product in period 1
P_2	Price of the product in period 2
S	Status utility an informative commenter derives per person who reads her comment
M_Z	Followers who derive zero value from the product
M_V	Followers who derive value V from product with good fit
β	Probability that any given customer arrives in the first group
R	Cost of reading each comment
C	Marginal production cost for the product

4 Results

We derive the optimal endorsement policy and equilibrium profits. Our solution concept is perfect Bayesian equilibrium, which requires that players have correct beliefs on the equilibrium path, and that no player has a profitable deviation after any possible history. To restrict beliefs off the equilibrium path, we use the intuitive criterion, which is a standard equilibrium refinement (Cho and Kreps 1987).

4.1 First period price and customer behavior

We now derive equilibrium price and customer behavior in the first period following a product endorsement by the influencer. Customers form quality expectations based on the influencer's endorsement policy, and also form expectations of the status utility from commenting based on this endorsement policy.

The appendix contains a formal proof of the following result.

Lemma 1. *The seller sets first period price equal to the maximum willingness to pay of customers who are interested in the product.*

The willingness to pay of customers in the first period depends on their quality expectations and their expected status utility from writing informative comments. We will explicitly derive the first period product price given an endorsement by high and low entertainment influencers below.

Lemma 1 implies the first group of customers make M_V informative comments and M_Z uninformative comments. Letting λ denote the fraction of comments that are informative, we have the following.

$$\lambda = \frac{M_V}{M_Z + M_V} \tag{1}$$

These results imply that a more entertaining influencer generates a lower fraction of informative comments because a greater proportion of followers read the post due to their interest in the influencer rather than their interest in the product. For

example, imagine two vegan chefs on Instagram. One influencer has a small following and is only somewhat entertaining. He attracts people who care passionately about vegan food (most of his followers are in the M_V group). The other influencer is very entertaining. He attracts even more of the people who are interested in vegan food (his value of M_V is larger than the smaller influencer's value of M_V) but he also attracts a segment of followers (the M_Z group) who do not care much about vegan food and like him mostly for his entertaining commentary. Thus, the larger influencer generates a smaller fraction of informative comments. Similarly, we could compare a soccer player with a small following of passionate soccer fans with another soccer player with many followers who like him partly for his glamour and appearance. In each case, the larger influencer has a smaller proportion of fans who have a strong interest in his key product.[5]

However, because larger influencers typically have a larger number of both types of followers (both the M_V group and the M_Z group), an endorsement by a celebrity influencer may generate much higher profits than an endorsement by a micro-influencer, even if the celebrity endorses products with lower average quality. The large M_V group among their followers explains why celebrities are able to negotiate much higher sponsorship fees than micro-influencers.

4.2 Customer behavior in the second period

We now derive the optimal strategy for customers in the second period conditional on having read the influencer's post. At this stage of the game, customers have observed the influencer's endorsement policy and the current price P_2. Let $\widetilde{q}$ denote customers' beliefs about expected product quality, and let $\widetilde{\lambda}$ denote customer beliefs about the fraction of comments that are informative. In equilibrium, these beliefs must be accurate given the strategies of all other players.

[5]A previous version of this paper explicitly modeled the influencer's entertainment level and made the shift in the type of followers who read the post endogenous as entertainment increases. For simplicity of exposition, we no longer include the entertainment level as a formal variable in the model.

Lemma 2. *In period two, the utility-maximizing strategy for a customer who is interested in the product is as follows. If* $(1-\widetilde{q})P_2 \leq \frac{R}{\widetilde{\lambda}}$ *and* $\widetilde{q}V \geq P_2$*, the customer purchases the product without reading any comments. If* $(1-\widetilde{q})P_2 > \frac{R}{\widetilde{\lambda}}$ *and* $\widetilde{q}V \geq \widetilde{q}P_2 + \frac{R}{\widetilde{\lambda}}$*, the customer reads comments until finding an informative comment, and purchase the product if it is a good fit. Otherwise, the customer does not read any comments and does not purchase.*

Intuitively, each customer who reads the post in the second period faces the following dynamic optimization problem. She can either purchase immediately, or incur cost R to read a comment which has probability $\widetilde{\lambda}$ of revealing whether the product is a good fit for her. If the customer reads an informative comment, she purchases the product only if it is a good fit. If she reads an uninformative comment, then the cost R of reading that comment is now a sunk cost. Therefore, she faces the same dynamic optimization problem as before, and if reading the first comment was optimal, then it is also optimal to read another comment after finding an uninformative comment (see the proof in the appendix for additional detail).

The strategy of purchasing immediately leads to a probability $1-\widetilde{q}$ of paying price P_2 for a product that is a poor fit. The strategy of reading comments avoids this cost of purchasing a product that is a poor fit but also incurs an additional expected cost $\frac{R}{\widetilde{\lambda}}$ of reading comments. The customer chooses a strategy based on which of these costs is lower. Finally, if both of these strategies produce negative expected utility, the customer simply does not read comments and does not purchase.

4.3 High entertainment influencer

In order to study the distinct strategies of micro and celebrity influencers, we focus our analysis on low and high values of λ. In particular, the fraction of followers who are interested in the product is given by $\lambda \in \{\lambda_L, \lambda_H\}$, where $0 < \lambda_L < \lambda_H$.

We now derive the equilibrium outcome given an endorsement by a high entertainment influencer. We focus on cases in which a high entertainment influencer

generates so many uninformative comments, and thus λ_H is so small, that the following conditions hold:

Condition 1. $(1-\widetilde{q})\widetilde{q}V < \frac{R}{\lambda_H}$, $\forall \widetilde{q} \in \{\overline{q}, \alpha\overline{q}+(1-\alpha)\underline{q}\}$

Condition 2. $\overline{q}\Big[V - C - \frac{R}{\overline{q}\,\lambda_H}\Big] < [\alpha\overline{q}+(1-\alpha)\underline{q}]V - C$

These conditions are guaranteed to hold if the number of customers who read the influencer's post purely for entertainment, given by M_Z, is sufficiently large.

We can now derive the equilibrium outcome for a high entertainment influencer. In this case, $\widetilde{q}$ denotes customers' beliefs about expected product quality given the endorsement policy of a high entertainment influencer, that is, $\widetilde{q} = \overline{q}$ if the influencer endorses only high quality products, and $\widetilde{q} = \alpha\overline{q}+(1-\alpha)\underline{q}$ if he endorses all products.

Lemma 3. *Given Conditions 1 and 2, the equilibrium given an endorsement by a high entertainment influencer is as follows. The firm sets* $P_1 = \widetilde{q}V$ *and also sets* $P_2 = \widetilde{q}V$*. Customers who are interested purchase the product immediately after they read the post, without reading any comments in period 2.*

The intuition for this result is the following. (See the appendix for formal proofs of this and all other results.) The equilibrium first period price is just low enough to induce customers who read the post to purchase, $P_1 = \widetilde{q}V_L$. Under Condition 1, Lemma 2 implies that if the firm maintains second period price $P_2 = \widetilde{q}V_L$, customers who read the post will purchase without reading comments. The firm has two options. It can maintain the same price as in the first period, or it can set a higher price that induces customers to read comments before purchasing. Under Condition 2, the fraction of informative comments (λ_H) is so low that the strategy of setting a high price to induce customers to read comments is either infeasible (there is no price at which customers prefer to read comments rather than purchase immediately) or less profitable than the strategy of maintaining the same price as in the first period, even if the firm truly has high quality and customers perceive a higher price as a signal of high quality. Thus, for a high entertainment influencer, the firm sets the same price in both periods, and customers do not read any comments.

We now derive the influencer's equilibrium endorsement policy. We assume Conditions 1 and 2 hold, which we have shown implies, in equilibrium, followers do not read comments on a high entertainment influencer's post. Because the influencer and seller proportionally split the profits from the endorsement deal, the influencer will choose whichever endorsement strategy leads to the highest expected profits.

Based on Lemma 3, if a high entertainment influencer endorses all products, expected profits are:

$$E[\pi] = \Big([\alpha\overline{q} + (1-\alpha)\underline{q}]V - C\Big)M_V \tag{2}$$

Lemma 3 also implies, if a high entertainment influencer endorses only high quality products, expected profits are:

$$E[\pi] = \alpha\Big(\overline{q}V - C\Big)M_V \tag{3}$$

In both of these equations, the first part of the profit expression is expected profits per follower who is interested in the product, which is then multiplied by the number of followers M_V who are interested in the product. As we would expect, for either endorsement policy, an influencer with a larger number of followers interested in the product generates higher expected earnings.

Note that, if $\underline{q}V > C$, profits are higher from endorsing all products rather than only high quality products. Intuitively, for a high entertainment influencer, followers do not read comments and do not learn whether the product is a good fit prior to purchase. Therefore, the firm sets the price equal to the *ex ante* expected value that a customer receives from the product ($\widetilde{q}V$). As long as a customer's expected value from a low quality product exceeds the product's marginal cost, endorsing all products allows the seller to capture additional surplus generated by selling low quality products, and expected profits are maximized by endorsing both high and low quality products.

Proposition 1. *A high entertainment influencer endorses all products if* $\underline{q}V > C$*, and endorses only high quality products if* $\underline{q}V < C$*.*

4.4 Low entertainment influencer

We now derive the equilibrium outcome given an endorsement by a low entertainment influencer. We focus on cases in which a low entertainment influencer generates a high enough fraction of informative comments (λ_L is large enough) that the following conditions hold. We will show that under Condition 3 if a low entertainment influencer endorses only high quality products, in the second period the seller sets its price high enough that customers read comments before deciding whether to purchase, rather than setting a lower price that would induce customers to purchase immediately without reading comments. Similarly, we will show that under Condition 4 if a low entertainment influencer endorses all products, in the second period the seller sets its price high enough that customers read comments before deciding whether to purchase.

Condition 3. $\overline{q}\Big[V - C - \frac{R}{\overline{q}\lambda_L}\Big] > \frac{R}{(1-\overline{q})\lambda_L} - C$

Condition 4. $\underline{q}\Big[V - C - \frac{R}{[\alpha\overline{q}+(1-\alpha)\underline{q}]\lambda_L}\Big] > \frac{R}{(1-\underline{q})\lambda_L} - C$

We can now derive the equilibrium outcome for the subgame in which the firm chooses a low entertainment influencer. In this case, $\widetilde{q}$ denotes customers' beliefs about expected product quality given an endorsement from a low entertainment influencer, that is, $\widetilde{q} = \overline{q}$ if the influencer endorses only high quality products, and $\widetilde{q} = \alpha\overline{q} + (1-\alpha)\underline{q}$ if he endorses all products.

Lemma 4. *Given Conditions 3 and 4, the equilibrium given an endorsement by a low entertainment influencer is as follows. In the first period, the firm sets* $P_1 = \widetilde{q}V + \frac{S(1-\beta)}{\beta}$*. In the second period, the firm sets* $P_2 = V - \frac{R}{\widetilde{q}\lambda_L}$*. In period one, customers who are interested in the product purchase immediately after reading the post. In period two, customers who are interested in the product read comments until they find an informative comment and purchase only if the product is a good fit.*

The intuition for this result is the following. In the first period, the firm sets price $\widetilde{q}V + \frac{S(1-\beta)}{\beta}$, which is just low enough to induce customers to purchase. Note the term $\frac{S(1-\beta)}{\beta}$ reflects the expected status utility from leaving an informative comment in the first period. In period two, the firm has two options. It can set price at the maximum level that induces customers to purchase immediately without reading comments, or it can set a higher price equal to the maximum level for which customers are willing to read comments and then purchase if fit is good. Under Conditions 3 and 4, the fraction of informative comments is high enough that the firm always prefers the strategy of setting a higher price so customers read comments, and customers purchase the product only if it is a good fit for them. Thus, for a low entertainment influencer, customers in the first period derive status utility from their informative comments, and customers in the second period read comments before deciding whether to purchase.

We now derive the influencer's equilibrium endorsement policy. We assume Conditions 3 and 4 hold, which we have shown implies, in equilibrium, second period followers read comments on a post by a low entertainment influencer.

The influencer will choose whichever endorsement strategy leads to the highest expected profits. Based on Lemma 4, if a low entertainment influencer endorses all products, expected profits are:

$$E[\pi] = \beta\left([\alpha\overline{q} + (1-\alpha)\underline{q}]V + \frac{S(1-\beta)}{\beta} - C\right)M_V + \tag{4}$$
$$(1-\beta)[\alpha\overline{q} + (1-\alpha)\underline{q}]\left[V - C - \frac{R}{[\alpha\overline{q} + (1-\alpha)\underline{q}]\lambda_L}\right]M_V$$

Lemma 4 also implies, if a low entertainment influencer endorses only high quality products, expected profits are:

$$E[\pi] = \alpha\beta\left(\overline{q}V + \frac{S(1-\beta)}{\beta} - C\right)M_V + \tag{5}$$
$$(1-\beta)\alpha\overline{q}\left[V - C - \frac{R}{\overline{q}\lambda_L}\right]M_V$$

By comparing these two profit functions and rearranging terms, we find that the incremental profits from endorsing all products (instead of just high quality products) is the following:

$$(1-\alpha)\left[\underline{q}V - \beta C - (1-\beta)\underline{q}C + S(1-\beta) - \frac{R(1-\beta)}{\lambda_L}\right]M_V \tag{6}$$

Intuitively, endorsing low quality products affects profits in three ways. First, it allows the seller to capture surplus from the difference between the expected value of these products and their marginal cost (in the second period the firm incurs production cost only for customers who find the product is a good fit). Second, it allows first period customers to attain status utility from commenting on these products. Third, it imposes a cost on second period customers by inducing them to spend time reading comments about these products. In other words, each additional product a low entertainment influencer endorses leads to additional costs for his followers that result from the time they spend reading comments. If this reading cost is too high relative to the surplus from consuming low quality products and the status utility from commenting on these products, then the influencer prefers to endorse only high quality products.

Proposition 2. *A low entertainment influencer endorses only high quality products if* $(1-\beta)\left(\frac{R}{\lambda_L} - S\right) > \underline{q}V - \beta C - (1-\beta)\underline{q}C$*, and endorses all products if this inequality is reversed.*

Thus, our model implies a key difference between influencer types is that low entertainment influencers try to protect the time of their followers, so these followers do not waste time reading comments about low quality products. Because high entertainment influencers have so many uninformative comments that followers do not read the comments in any case, these influencers do not face this same concern, and big celebrity influencers may be more inclined to endorse all types of products.

For modeling parsimony and clarity, we have focused our analysis on low values of λ for which followers never read comments and high values of λ for which they

always read comments in equilibrium. If the fraction of informative comments lies in an intermediate range, other types of equilibria are possible. For example, in some cases with intermediate values of λ, price can act as a quality signal, and followers in the second period read comments only for high quality products with a high price, whereas they purchase low quality products immediately at a lower price without reading comments. In this case, reading costs would not affect the influencer's endorsement decision because, in equilibrium, followers do not read comments on low quality products.

In addition, the appendix contains four extensions of our model. The first extension relaxes the assumption that the influencer's endorsement policy is binding and derives conditions in which reputation concerns compel the influencer to maintain a policy of endorsing only high quality products. The second model extension assumes the influencer sometimes cannot observe product quality and shows that a low entertainment influencer may want to specialize in endorsing products for which he has the expertise to observe quality. The third model extension allows the influencer to delete some of the uninformative comments and shows that a low entertainment influencer would like to delete these comments, but in some cases, a high entertainment influencer prefers to keep uninformative comments on his post so followers purchase the product without reading comments. The fourth extension develops a more detailed model of the costs and benefits of writing comments, and we adapt our results to this alternative model of commenting.

4.5 Numerical example

We now present a numerical example to help provide more intuition for the influencer's equilibrium endorsement policy. Table 2 presents the parameter values used for the numerical example, which satisfy all of the conditions of model.

Based on results from the previous sections, we derive the equilibrium outcome for each type of influencer and each endorsement policy. For a high entertainment influencer, the fraction of informative comments is $\lambda_H = 0.025$, so on average a

customer would need to read 40 comments to find an informative comment. For a low entertainment influencer, with $\lambda_L = 0.18$, a customer needs to read only 5.6 comments on average to find an informative comment. For these parameter values, customers in the second period read comments for a low entertainment influencer but not for a high entertainment influencer.

Table 2. Parameter values used in the numerical example

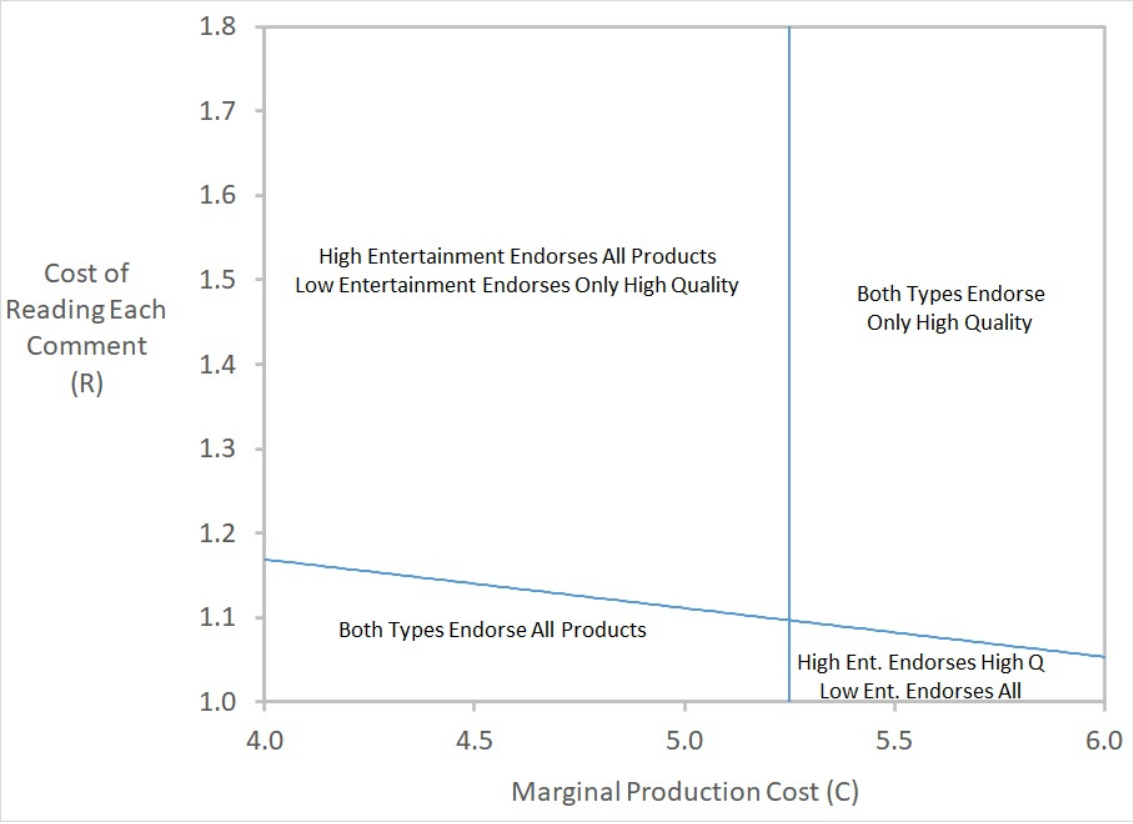
$\alpha = 0.2$	Probability that the product has high quality
$\underline{q} = 0.07$	Probability that low quality product meets customer i's needs
$\overline{q} = 0.7$	Probability that high quality product meets customer i's needs
$V = 75$	Utility from consuming product that is a good fit
$S = 1.2$	Status utility an informative commenter derives per person who reads her comment
$\beta = 0.2$	Probability that any given customer arrives in the first group
$R = 1.8$	Cost of reading each comment
$C = 4.5$	Marginal production cost for the product
$\lambda_L = 0.180$	Fraction of informative comments for low entertainment influencer
$\lambda_H = 0.025$	Fraction of informative comments for high entertainment influencer

If a high entertainment influencer endorses all products, the equilibrium price in both periods is 14.7, which given a marginal production cost of 4.5 implies total profits are $(14.7-4.5)M_V = 10.2M_V$. If the high entertainment influencer endorses only high quality products, then there is a probability 0.2 that he endorses the product, the price in both periods is 52.5, and total expected profits are $0.2(52.5 - 4.5)M_V = 9.6M_V$. Thus, for a high entertainment influencer, the strategy of endorsing all products, with low average quality and low equilibrium price, generates 6% higher profits than the strategy of being more selective and endorsing only high quality products with higher equilibrium price (profits are $10.2M_V$ versus $9.6M_V$).

If a low entertainment influencer endorses all products, the first period price is 19.5; the second period price is 24.1, and second period customers read comments before purchasing, which results in a fraction 0.196 of these second period customers

finding the product is a good fit and purchasing. Total profits are $[0.2 * (19.5 - 4.5) + 0.8 * 0.196 * (24.1 - 4.5)]M_V = 6.1M_V$. If a low entertainment influencer endorses only high quality products, there is probability 0.2 that he endorses the product. In this case, the first period price is 57.3. The second period price is 60.7, and second period customers read comments before deciding whether to purchase, which results in a fraction 0.7 of these customers finding the product is a good fit and purchasing. Total profits are $0.2[0.2 * (57.3 - 4.5) + 0.8 * 0.7 * (60.7 - 4.5)]M_V = 8.4M_V$. Thus, for a low entertainment influencer, profits are 39% higher if the influencer is selective and endorses only high quality products, rather than endorsing all products (profits are $8.4M_V$ versus $6.1M_V$).

Figure 1. Influencer's equilibrium endorsement policy



To illustrate comparative statics for our results, Figure 1 presents the equilibrium endorsement policies using the same numerical values as above. When both costs

(reading cost R and production cost C) are high, both influencer types endorse only high quality products. When both costs are low, both types endorse all products. When the production cost is relatively low but the cost of reading comments is relatively high, the high entertainment influencer endorses all products, whereas the low entertainment influencer endorses only high quality products. Finally, there is a region in the bottom-right of the figure in which a high entertainment influencer endorses only high quality products because production cost is so high that it is not profitable to sell a low quality product to all customers, whereas a low entertainment influencer endorses all products because the reading cost is low enough that customers can easily learn whether the product is a good fit. Thus, the high entertainment influencer's endorsement strategy depends on the marginal production cost of the product, whereas the low entertainment influencer's endorsement strategy depends mostly on the marginal cost of reading comments.

5 Conclusion

Our paper creates a model of sponsored influencer and follower communication about a product. An influencer decides which types of products to endorse, and followers can read the influencer's post and leave comments for future customers. We derive conditions in which a less entertaining influencer, on average, endorses higher quality products. In equilibrium, a large celebrity influencer who generates widespread product awareness but uninformative comments endorses all products, whereas a smaller micro-influencer whose followers write informative comments endorses only high quality products. A key difference is that smaller influencers avoid endorsing low quality products so their followers do not waste time reading comments about a product that is unlikely to be a good fit.

Influencer advertising is one of the fastest growing areas of marketing, with campaigns spanning industries ranging from beauty and fitness to vaccination campaigns (Tiffany 2021; Ravindranath 2021). However, managers have found that micro-influencers often refuse paid endorsement deals (Carufel 2021; Baklanov 2021). Our results can help managers target influencers who are willing to form a partnership. If a firm wants to create deep engagement with followers who share product information, then it should produce a high quality product and work with micro-influencers with expertise in the product. For example, the state of Alaska ran a marketing campaign that paid "chefs and culinary influencers" to promote recipes that use Alaskan salmon, and these micro-influencers encouraged followers to share their own cooking tips and seafood recipes (Albright and Moran 2022; Alaska Seafood 2022). By contrast, if a firm's goal is simply to create widespread product awareness, it should work with large celebrity influencers, who are generally willing to endorse almost any firm that pays their endorsement fee. For example, reality television star Kim Kardashian was paid $250 thousand to make an Instagram post promoting the EthereumMax cryptocurrency token (Calia and Corba 2022).

Future research could empirically test some of the model's predictions. Our model predicts that small influencers accept an endorsement deal only if the product has high quality and fits their expertise, whereas celebrity influences are willing to endorse low quality products unrelated to their expertise. Our model also predicts that smaller influencers generate deeper engagement with more informative comments, and are more likely to have a policy of deleting irrelevant comments.

Future research could also develop a dynamic model of influencer reputation to study how endorsement policies change as an influencer's following grows. Classic models of reputation formation have studied conditions in which larger or smaller firms have a stronger incentive to invest in their reputation (e.g., Board and Meyer-

ter-Vehn 2013). In the social media context, a new influencer may initially endorse only high quality products in their area of expertise, but later begin endorsing products with lower quality levels and products outside their area of expertise after they develop a sufficiently large following.

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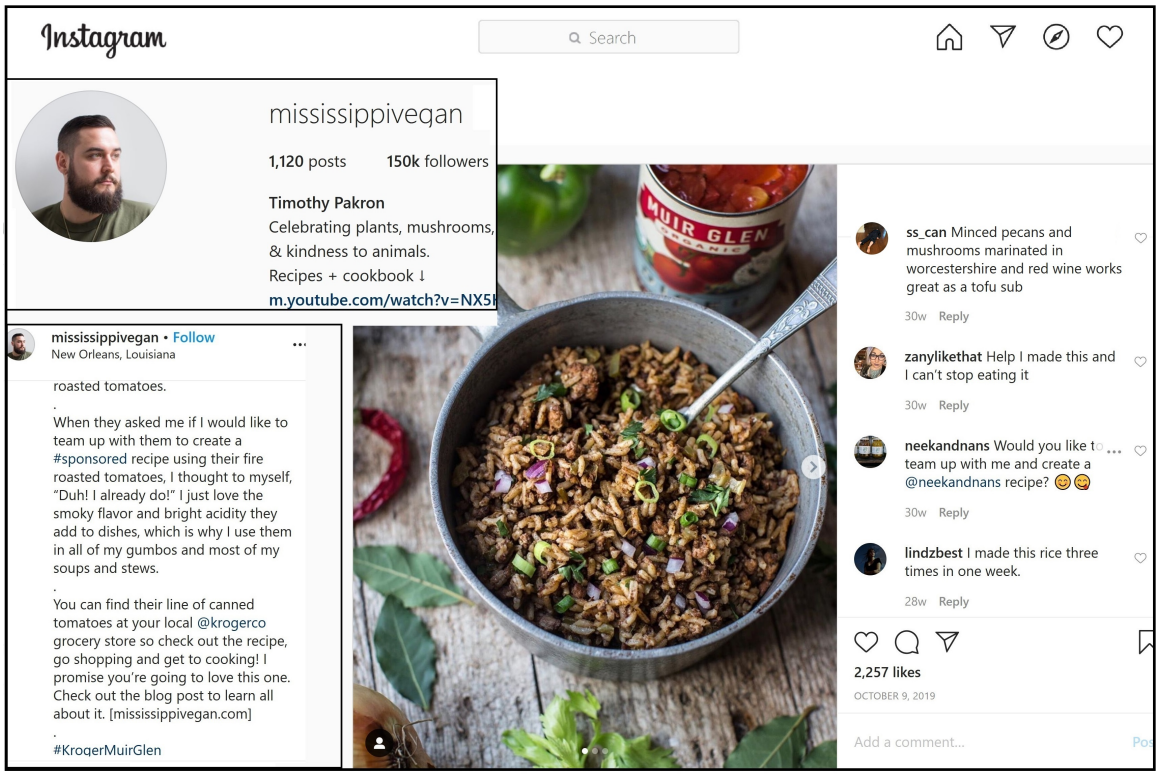
Appendix A: Influencer Examples

Cristiano Ronaldo, Sponsored Post on Instagram

Retrieved May 15, 2020, https://www.instagram.com/p/B5SFl7YK0Px/

Vegan Chef, Sponsored Post on Instagram



Retrieved May 15, 2020, https://www.instagram.com/p/B3ar1oKngcJ/

Appendix B: Model extensions

This appendix contains four model extensions. These extensions allow for influencer reputation, influencer specialization, the influencer to delete uninformative comments, and additional costs and benefits of commenting.

Model extension: Influencer reputation

This model extension relaxes the assumption that the influencer's endorsement policy is binding, and we derive conditions in which reputation effects compel the influencer not to deviate from his chosen endorsement policy.

The influencer first announces a non-binding endorsement policy that specifies whether he endorses all products or only high quality products. There is then a new product the influencer can endorse in each period $t \in \{1, 2, \ldots\}$. Similar to previous reputation models (e.g., Kreps and Wilson 1982; Bar-Isaac 2003; Selove 2019), we assume all players learn at the end of period t about any deviation from the influencer's endorsement policy, for example, through news stories or online word-of-mouth. We show that, under some conditions, this threat of loss of reputation provides an incentive for the influencer to maintain a policy of endorsing only high quality products.

The game timing in each period t is the following:

1. Nature chooses the quality level for the period t product, which the influencer observes.

2. The influencer decides whether to endorse the product. If he does not endorse the product, the subgame for period t ends with no payoffs for the period.

3. The firm and the influencer bargain over a fixed payment the firm makes to the influencer in period t.

4. The firm sets the period t product price for the first group of customers.

5. The first group of customers read the influencer's post, learn the product's current price, have the option to buy the product, and leave comments.

6. The firm sets the period t product price for the second group of customers.

7. The second group of customers read the influencer's post and learn the product's current price. They can then read comments and have the option to buy the product.

In a one-shot version of this game, with a nonbinding endorsement policy, the influencer would endorse all products. The influencer could not credibly promise to endorse only high quality products, because he would then have an incentive to endorse the product and earn positive profits even if it has low quality. Therefore, the only possible equilibrium of a one-shot version of this game involves the influencer endorsing all products and customer beliefs that the endorsement does not convey any quality information. We focus on an equilibrium of our repeated game in which, if the influencer ever deviates from his announced endorsement policy, players revert to this one-shot equilibrium in all subsequent periods. This punishment strategy provides the strongest possible incentive for the influencer not to deviate because it implies, if the influencer ever violates an announced policy of endorsing only high quality products, then followers will always believe he endorses all products and never again believe his claim that the products he endorse all have high quality.

We focus our analysis on a low entertainment influencer, although we could also perform similar derivations of reputation effects for a high entertainment influencer. Consider a proposed equilibrium in which the influencer endorses only high quality products, and suppose the fraction of informative comments (λ_L) is high enough that

Conditions 3 and 4 hold. If the influencer deviates and endorses a low quality product in period t, Lemma 4 implies he will generate the following profits for the period:

$$\left[\beta\left(\overline{q}V + \frac{S(1-\beta)}{\beta} - C\right) + (1-\beta)\underline{q}\left(V - C - \frac{R}{\overline{q}\lambda_L}\right)\right]M_V \tag{7}$$

Profits for this equilibrium deviation involve customers beliefs that quality is high ($\overline{q}$), but in the second period only a low fraction of customers ($\underline{q}$) find the product is a good fit because quality is actually low.

This deviation from the proposed equilibrium causes all future periods to revert to the equilibrium in which the influencer endorses all products instead of only high quality products. The resulting change in expected profits in each future period is given by expression (6). If the inequality in Proposition 2 holds, this expression is negative, that is, profits are lower when the influencer endorses all products. Letting δ denote the influencer's discount factor, this threat of lost future profits is sufficient to prevent the influencer from endorsing a low quality if the following condition holds:

Condition 5.

$$\begin{aligned}&\left[\beta\left(\overline{q}V + \frac{S(1-\beta)}{\beta} - C\right) + (1-\beta)\underline{q}\left(V - C - \frac{R}{\overline{q}\lambda_L}\right)\right] \leq \\ &\frac{\delta(1-\alpha)}{1-\delta}\left[-\underline{q}V + \beta C + (1-\beta)\underline{q}C - S(1-\beta) + \frac{R(1-\beta)}{\lambda_L}\right]\end{aligned} \tag{8}$$

Intuitively, when this condition holds, the short-term profits from endorsing a low quality product in any period t are less than the discounted value of the lost future profits that result from imposing additional reading costs on followers by moving to an equilibrium in which the influencer endorses all products. The following proposition states this result formally.

Proposition 3. *If Condition 5 holds, a low entertainment influencer can sustain a*

policy of endorsing only high quality products, even if its endorsement policy is not binding.

For the numerical example in section 4.5, Condition 5 holds for any $\delta \geq 0.86$. If this condition holds, the influencer can sustain his optimal endorsement policy, based on the threat of loss of reputation and lost future profits if it ever deviates from this policy.

Model extension: Influencer specialization

In this model extension, the influencer can either specialize in endorsing products for which he has expertise, or he can also endorse products outside his expertise.

Similar to the literature on expert certification (e.g., Morrison and White 2005; Lerner and Tirole 2006), we model expertise as the ability to evaluate a product's quality level. Suppose there is probability γ the influencer can observe the product's quality level, and probability $1 - \gamma$ he cannot observe quality, where $0 < \gamma < 1$. When nature determines the product's quality level, it also independently determines whether the influencer has the expertise to evaluate quality. The influencer and firm can observe whether the influencer has expertise in that particular product, but followers cannot. For example, a chef may be an expert in certain types of food but not others, and followers may be unaware of which types of food fall in each category.

When the influencer chooses his endorsement policy, he now has three options: (1) endorse all products, (2) specialize in endorsing only products for which he has expertise and quality is high, (3) endorse products for which he has expertise and quality is high and also all products for which he lacks expertise. All other model assumptions remain the same.[6]

[6]For simplicity of exposition, we return to the original model timing with a one-shot game and a binding choice of endorsement policy. In principle, we could derive conditions in which reputation effects compel the influencer to maintain his chosen policy, as in the previous model extension.

We now derive the influencer's optimal endorsement policy for this model extension. When results from previous sections imply the influencer endorses all products, expertise is irrelevant, and the influencer continues to endorse all products in the current model extension. For example, if $\underline{q}V > C$, Proposition 1 implies a high entertainment influencer endorses all products, including those for which he lacks expertise.

Now suppose results from the previous section imply the influencer endorses only high quality products. The decision to endorse products for which the influencer lacks expertise is then formally equivalent to the decision to endorse a low quality product in the original model, if the low quality product had quality level $\widehat{q} \equiv [\alpha\overline{q} + (1-\alpha)\underline{q}]$. We can therefore use results from the previous sections to derive the optimal endorsement policy.

Note that $\widehat{q}$ is the *ex ante* expected quality level of the product, and recall that we assumed in the initial model set-up that $\widehat{q}V > C$. Therefore, Proposition 1 implies the high entertainment influencer always endorses products for which he lacks expertise. By contrast, Proposition 2 implies a low entertainment influencer may not want to endorse products for which he lacks expertise because he wants to avoid imposing additional reading costs on his followers. These results are formally stated in the following proposition.

Proposition 4. *A high entertainment influencer endorses all products if* $\underline{q}V > C$*, and endorses high quality products for which he has expertise and also all products for which he lacks expertise if* $\underline{q}V < C < \widehat{q}V$*. A low entertainment influencer endorses all products if* $(1-\beta)\left(\frac{R}{\lambda_L} - S\right) < \underline{q}V - \beta C - (1-\beta)\underline{q}C$*, endorses high quality products for which he has expertise and also all products for which he lacks expertise if* $\underline{q}V - \beta C - (1-\beta)\underline{q}C < (1-\beta)\left(\frac{R}{\lambda_L} - S\right) < \widehat{q}V - \beta C - (1-\beta)\widehat{q}C$*, and endorses only high quality products for which he has expertise if* $\widehat{q}V - \beta C - (1-\beta)\widehat{q}C < (1-\beta)\left(\frac{R}{\lambda_L} - S\right)$.

Thus, whereas the high entertainment influencer endorses products for which he lacks expertise, the low entertainment influencer may avoid endorsing such products so that his followers do not waste time reading comments about low quality products.

Model extension: Deleting uninformative comments

We now allow the influencer to delete some of the uninformative comments on his post.

Previous research has developed models in which a seller can write biased reviews of their product which, in equilibrium, results in less informative comments (Mayzlin 2006), or can make informative comments easier to find by allowing customer reviews on the seller's website (Chen and Xie 2008). Similarly, we allow the influencer to choose a policy that affects the informativeness of comments. At the same time he sets his endorsement policy, the influencer can decide either to keep all of the comments on his post or to delete some uninformative comments. If a low entertainment influencer has a policy of deleting uninformative comments, the fraction of informative comments on his post increases to $\widehat{\lambda}_L$, where $\widehat{\lambda}_L \in (\lambda_L, 1]$. If a high entertainment influencer deletes uninformative comments, the fraction of informative comments increases to $\widehat{\lambda}_H$, where $\widehat{\lambda}_H \in (\lambda_H, 1]$. Note we allow for the possibility that the influencer is not able to delete all uninformative comments, so the fraction of informative comments could remain less than one.

Equations (4) and (5) show that a low entertainment influencer's equilibrium profits are strictly increasing in λ_L. Therefore, by reducing reading costs for second period customers, a policy of deleting uninformative comments increases profits for a low entertainment influencer.

For a high entertainment influencer, we assume $\widehat{\lambda}_H$ is high enough that inequalities equivalent to Conditions 3 and 4 hold for $\widehat{\lambda}_H$. Therefore, if a high entertainment

influencer has a policy of deleting uninformative comments, customers in the second period read comments on his post, and profits can then be derived using the same equations as for a low entertainment influencer in the original version of the model.

By comparing equation (2) with equation (4), and comparing (3) with (5), we see that deleting uninformative comments affects profits for the high entertainment influencer in three ways. First, by allowing second period customers to learn whether the product is a good fit, this policy allows the seller to avoid the cost of producing the product for customers for whom it is a bad fit. Second, it allows first period customers to gain status utility from writing informative comments. Third, it causes customers in the second period to incur costs of reading comments about the product. The net effect can go in either direction, that is, a policy of deleting uninformative comments could increase profits if production costs and status utility are relatively large, but could also reduce profits if the reading costs are relatively large.

These results are formalized in the following proposition.

Proposition 5. *For a low entertainment influencer, deleting uninformative comments increases profits. For a high entertainment influencer, deleting uninformative comments increases the profits from a given endorsement policy if and only if* $(1-\widetilde{q})C + S > \frac{R}{\widehat{\lambda}_H}$*, where* $\widetilde{q}$ *is expected quality given the influencer's endorsement policy.*

Thus, a high entertainment influencer may or may not want to delete uninformative comments. Intuitively, if production costs are low relative to the cost of reading comments, it is more profitable to have all customers purchase the product without reading comments, so a high entertainment influencer prefers to keep uninformative comments on his post.

Model extension: Costs and benefits of commenting

This model extension develops a richer model of the costs and benefits of commenting, and we adapt our results to this model extension.

For follower i, denote the cost of writing a comment by k_i. These writing costs are iid random variables, equal to k_H with probability ϕ, and equal to k_L with probability $1-\phi$, where $0 < k_L < k_H$. Let N denote the expected number of readers for each comment. All followers can write an uninformative comment, from which they derive utility $e + UN - k_i$. Followers who purchase the product may, alternatively, write an informative comment, from which they derive utility $e + SN - w - k_i$. Here e denotes the inherent entertainment utility from commenting, w is the additional cost of writing an informative comment, and U and S represent the additional utility per comment reader from writing an uninformative and informative comment, respectively, where $0 < U < S$. We assume $k_L < e < k_H < e + \frac{(1-\beta)U}{\beta}$, which implies followers with low cost of commenting always write a comment, whereas those with high cost of commenting write a comment only if they expect second-period followers to read comments. We also assume $\frac{(1-\beta)(S-U)}{\beta} > w$, which intuitively means followers who are interested in the product prefer to write an informative rather than uninformative comment if they expect second-period followers to read comments.

If first-period followers expect the second-period followers not to read comments, then $N = 0$. In this case, first-period followers with low commenting costs write uninformative comments, and followers do not write any informative comments.

If first-period followers expect second-period followers who are interested in the product to read comments until finding an informative comment, then $N = \frac{1-\beta}{\beta}$. In this case, first-period followers who are not interested in the product write uninformative comments, whereas those who are interested in the product write informative comments.

Conditions 1 and 2 ensure that, for a high entertainment influencer, there cannot be an equilibrium with comment reading. Conditions 3 and 4 ensure that, for a low entertainment influencer, there is an equilibrium with comment reading.

All other model results remain the same, except for two key differences. First, for a low entertainment influencer, Lemma 1 implies the firm sets first-period price just high enough that followers interested in the product are indifferent between writing an uninformative comment without purchasing and writing an informative comment after purchasing, which implies $P_1 = \widetilde{q}V + \frac{(1-\beta)(S-U)}{\beta} - w$. Thus, the firm is not able to extract the full status utility from commenting, but only the amount by which this status utility exceeds the outside option of writing an uninformative comment.

The second difference is that, in the main version of the model, followers in both groups receive the same expected utility, whereas in this extension, for a low entertainment influencer, followers in the first group receive an additional utility of $\frac{(1-\beta)U}{\beta}$ from having their comments read. However, in this model extension, we let second-period followers have a better outside option for how to spend their time soon after the influencer posts, so it would be costly for them to read the post earlier as part of the first group. In particular, they would face an additional cost of at least $\frac{(1-\beta)U}{\beta}$ if they decided to read the post earlier, and so these followers wait and read the post as part of the second group.

Appendix C: Proofs

Proof of Lemma 1

Let $\widetilde{q}$ denote a first period customer's expectation of product quality given the influencer's endorsement policy, and let $\widetilde{n}$ denote her expectation of the number of second period customers that will read her informative comment if she writes one. A first period customer is willing to pay any price up to $P^* \equiv \widetilde{q}V + \widetilde{n}S$ for the product. Setting a price above P^* cannot act as a high quality signal because a low quality firm would have an incentive to imitate any higher price. Therefore, price P^* maximizes first period profits.

As shown below in Lemma 2, customers in the second period will base their search and purchase decisions on their beliefs about the fraction of informative comments, and if they read any comments, they continue reading until they find an informative comment. Customers in the second period do not observe the true fraction of informative comments or the first period price, which implies the firm's first period price cannot directly affect beliefs in the second period. Therefore, the firm's equilibrium strategy is to set first period price to maximize first period profits, that is, $P_1 = P^*$. Customer beliefs in the second period are then based on rational expectations about this first period price and the resulting purchase decisions of first period customers. QED

Proof of Lemma 2

One possible strategy for customers is to continue reading comments until finding an informative comment and then purchase the product if it is a good fit. Given the belief that a fraction $\widetilde{\lambda}$ of comments are informative, in expectation one has to read $\frac{1}{\widetilde{\lambda}}$ comments to find an informative comment, which implies the expected utility of

this strategy is $\widetilde{q}(V - P_2) - \frac{R}{\widetilde{\lambda}}$. Another possible strategy is to purchase immediately without reading any comments, which generates expected utility $\widetilde{q}V - P_2$. A third possible strategy is not reading any comments and not purchasing, which generates utility 0.

Among these three strategies, reading comments before deciding whether to purchase generates the highest expected utility if $(1-\widetilde{q})P_2 > \frac{R}{\widetilde{\lambda}}$ and $\widetilde{q}(V-P_2)-\frac{R}{\widetilde{\lambda}} \geq 0$, purchasing immediately generates the highest expected utility if $(1 - \widetilde{q})P_2 \leq \frac{R}{\widetilde{\lambda}}$ and $\widetilde{q}V - P_2 \geq 0$, and not reading comments or purchasing generates the highest expected utility otherwise.

Another feasible strategy would be to read a finite number of comments and stop searching if an informative comment has not yet been found. However, because the probability that the next comment will be informative and the probability that the product is a good fit do not change as the customer continues searching, the optimal threshold level of utility needed to stop search does not change over time (Kohn and Shavell 1974). Furthermore, reading an uninformative comment has no effect on the expected utility of stopping search and making a purchase decision immediately. Therefore, the same argument as in Kohn and Shavell (1974) for "static" search models implies, if it is optimal to read the first comment, it must also be optimal to continue reading comments after finding an uninformative comment, and reading a finite number of uninformative comments and then stopping search cannot be strictly better than continuing to search until an informative comment is found. QED

Proof of Lemma 3

Customer beliefs in the second period are based on rational expectations about the firm's first period pricing behavior, which, based on Lemma 1, implies $\widetilde{\lambda} = \lambda_H$ for a high entertainment influencer. We now derive the firm's equilibrium pricing decision

in period two given a fraction λ_H of informative comments. If customers maintain their prior quality expectation ($\widetilde{q}$), Lemma 2 and Condition 1 imply the highest price at which a customer would purchase immediately is $\widetilde{q}V$. Based on Lemma 2, if customers expect quality is high ($\overline{q}$), the highest possible price at which a customer would be willing to read comments and then purchase if fit is good is $P_2 = V - \frac{R}{\overline{q}\lambda_H}$. Condition 2 ensures both high and low quality firms prefer the former outcome, with price $\widetilde{q}V$ and immediate purchase, even if customers view the strategy of setting a high price to induce search as a signal of high quality.

Based on Lemma 1, given that first period customers rationally expect there is no status utility from commenting because no one will read comments in the second period, the firm sets set $P_1 = \widetilde{q}V$. QED

Proof of Lemma 4

Based on Lemma 1, $\widetilde{\lambda} = \lambda_L$ for a low entertainment influencer. We now derive the firm's equilibrium pricing decision in period two given a fraction λ_L of informative comments. Based on Lemma 2 and Conditions 3 and 4, the firm has two possible strategies in period two. It can set price $\frac{R}{(1-\widetilde{q})\lambda_L}$ so that customers purchase immediately, or it can set a higher price $\left[V - \frac{R}{\widetilde{q}\lambda_L}\right]$ so that customers read comments before deciding whether to purchase.

Suppose the influencer endorses only high quality products, so $\widetilde{q} = \overline{q}$. Condition 3 implies it is more profitable to set price $\left[V - \frac{R}{\overline{q}\lambda_L}\right]$ so a fraction $\overline{q}$ of customers purchase after reading comments, rather than setting the lower price $\frac{R}{(1-\overline{q})\lambda_L}$ which would induce all customers to purchase without reading comments.

Now suppose the influencer endorses both high and low quality products. We first show any potential equilibrium in which both firm types set price $\frac{R}{(1-[\alpha\overline{q}+(1-\alpha)\underline{q}])\lambda_L}$ and customers purchase immediately cannot satisfy the intuitive criterion. Condition 3

implies a high quality firm would deviate to price $\left[V - \frac{R}{\overline{q}\lambda_L}\right]$ if customers believe this higher price signals high quality. Furthermore, because a higher fraction of customers purchase after search if the firm has high quality than if it has low quality, there must exist a price such that the high quality firm prefers to deviate and the low quality firm does not if such a price deviation signals high quality. Thus, a pooling equilibrium on the low price cannot satisfy the intuitive criterion. Finally, Condition 4 implies a low quality firm prefers to set price $\left[V - \frac{R}{[\alpha\overline{q}+(1-\alpha)\underline{q}]\lambda_L}\right]$ and have a fraction $\underline{q}$ of customers purchase after reading comments rather than set the lower price $\frac{R}{(1-\underline{q})\lambda_L}$ and have all customers purchase immediately. Thus, in equilibrium both firm types set price $\left[V - \frac{R}{[\alpha\overline{q}+(1-\alpha)\underline{q}]\lambda_L}\right]$, and customers read comments before deciding whether to purchase.

These results imply each second period customer reads one informative comment. Based on Lemma 1, given that first period customers rationally expect there is status utility $\frac{S(1-\beta)}{\beta}$ from writing an informative comment, the firm sets set $P_1 = \widetilde{q}V + \frac{S(1-\beta)}{\beta}$. QED

Proof of Proposition 1

The profit functions for a high entertainment influencer given by (2) and (3) follow from Lemma 3, which applies if Conditions 1 and 2 hold. If $\underline{q}V > C$, the profits in (2) are greater than the profits in (3), which implies profits are maximized by endorsing all products. If $\underline{q}V < C$, the profits in (3) are greater than in (2), which implies profits are maximized by endorsing only a high quality product. Because the seller and influencer split the profits proportionally, the influencer chooses the endorsement policy that maximizes expected profits, which is a policy of endorsing all products. QED

Proof of Proposition 2

The profit functions given by (4) and (5) follow from Lemma 4, which applies if Conditions 3 and 4 hold. If $(1-\beta)\left(\frac{R}{\lambda_L}-S\right) > \underline{q}V - \beta C - (1-\beta)\underline{q}C$, the profits in (5) are greater than the profits in (4), which implies for a low entertainment influencer profits are maximized by endorsing only high quality products. If this inequality is reversed, the profits in (4) are greater, and the influencer maximizes profits by endorsing all products. Because the seller and influencer split the profits proportionally under Nash bargaining, the influencer chooses whichever endorsement policy maximizes expected profits. QED

Proof of Proposition 3 Under Conditions 3 and 4, Lemma 4 implies the profits from deviating and endorsing a low quality product are given by expression (7). Lemma 4 also implies the reduction in each period's future profits from moving to an equilibrium in which the influencer endorses all products is given by expression (6). Under Condition 5, the discounted value of this loss in future profits is greater than the one time benefit from deviating and endorsing a low quality product. Therefore, the influencer can sustain the equilibrium in which he endorses only high quality products, and the threat of moving to the bad equilibrium in which he endorses all products prevents him from deviating. QED

Proof of Proposition 4 A policy of endorsing only high quality products for which the influencer has expertise leads to probability $\gamma\alpha$ of an endorsement, and conditional on an endorsement, expected quality is $\overline{q}$. A policy of endorsing high quality products for which the influencer has expertise and also all products for which he lacks expertise leads to probability $\gamma\alpha+(1-\gamma)$ of an endorsement, and conditional on an endorsement, expected quality is $\frac{\gamma\alpha\overline{q}+(1-\gamma)\widehat{q}}{\gamma\alpha+(1-\gamma)}$. For a high entertainment influencer, similar derivations to those in the original model show that the latter policy generates higher profits if

$\widehat{q}V > C$. For a low entertainment influencer, similar derivations to those in the original model show that the latter policy generates higher profits if $\widehat{q}V - \beta C - (1-\beta)\widehat{q}C > (1-\beta)\left(\frac{R}{\lambda_L} - S\right)$. Finally, a policy of endorsing all products leads to probability one of an endorsement, and conditional on an endorsement, expected quality is $\widehat{q}$. Similar derivations to those in the original model yield conditions in which this policy generates the greatest profits. QED

Proof of Proposition 5 For a low entertainment influencer, equations (4) and (5) show that profits are strictly increasing in λ_L. For a high entertainment influencer, comparing equation (2) with equation (4) and substituting $\lambda_L = \widehat{\lambda}_H$ shows that deleting comments increases the profits from endorsing all products if $(1 - [\alpha\overline{q} + (1-\alpha)\underline{q}])C + S > \frac{R}{\widehat{\lambda}_H}$, and comparing (3) with (5) and substituting $\lambda_L = \widehat{\lambda}_H$ shows that deleting comments increases the profits from endorsing only high quality products if $(1-\overline{q})C + S > \frac{R}{\widehat{\lambda}_H}$. QED