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Obfuscated Signaling: Analyzing and Predicting Changes in Branding in the Fashion Industry

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ABSTRACT

As time goes on, sentiments change. This statement is perhaps best observed in the mercurial nature of the fashion industry, where styles and brands are constantly evolving. These changes may seem random, or simply a product of what celebrities enjoy at the moment. However, upon closer investigation, an interesting trend appears: the movement of designer brands towards smaller and more simplistic logos. These changes are by no means insignificant; advertising is one of the most important aspects of a brand, and its costs are substantial. Because of these costs, brands only aim to change logos when they feel they need to match a change in fashion or a cultural shift. Thus, by analyzing when and how brands change their logos, researchers can predict and capitalize upon trends in the fashion industry. However, it is still unclear as to why brands have specifically moved to more simplistic appearances. What is the appeal for newer styles to be more discreet, humble, and less ostentatious? To understand this phenomenon, we propose a model that analyzes the change in preferences and motivations in both fashion and culture across generations. Using this model, we achieve results that give further insight into how this knowledge can be used to predict and capitalize upon future trends.

Keywords: Behavioral Economics; Branding; Fashion; Logos; Trends

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1. Motivation

As time goes on, sentiments change. This statement is perhaps best observed in the mercurial nature of the fashion industry, where new styles are ever-present. These changes may seem random or unplanned, and especially in the modern day, simply a product of what certain celebrities enjoy at the time. However, upon closer investigation, an interesting trend that appears is the global trend of big brands moving towards smaller and more simplistic logos.

For instance, Louis Vuitton has just recently turned away from their Serif-font overlapping L and V, opting instead for a sharp and simple 4-line L over V as seen in Figure S1. Even outside of the fashion industry, famous brands have minimalized their logos. Pepsi-Cola's retro script logo combined with its large red, white, and blue circle on ornate backgrounds have been traded for an all lowercase, centralized "pepsi" with a modest, simple, unshaded circle and a plain navy background. The evolution of some smartphones also reveals the same trend, with each new iPhone attempting to take away buttons and ports that are deemed unnecessary for the aesthetic of a simple, full-screened phone. While on the topic of Apple, many of their built-in applications have changed to look simpler. Perhaps the most noticeable is the change in the App Store logo, which has gone from an "A" constructed of a pen, brush, and ruler to something that looks much closer to an equilateral triangle with three plain, overlapping lines.

These changes are by no means small. Advertising is one of the most important aspects of a brand, as its costs are substantial. The U.S. Small Business Administration recommends "As a general rule, small businesses with revenues less than $5 million should allocate 7-8 percent of their revenues to marketing." On the other hand, luxury goods companies, allocate a percentage close to 33%, Guttman (2018). Since marketing is no small task, brands should only aim to change logos when they feel a need to match the times, signaling what they may believe to be a change in fashion. Thus, by analyzing when and how brands change their logos, potential changes can be capitalized upon.

However, even knowing this, it is still unclear as to why brands have specifically moved to more simplistic appearances. What is the appeal for newer styles to be more discreet, hum- ble, and less ostentatious? We believe that the answer to this question lies in the change in disposable income over time. Figure S2 from Chao (2006) shows a clear trend: the percentage of a household's income spent on non-essential goods increases dramatically through the 20th century.

This realm of non-essential goods encompasses the increasing interest in luxury goods brands. We will show that as ostentatious luxury goods become more accessible, they also become less

Figure S1: Old LV Logo (Left) vs. New LV Logo (Right)

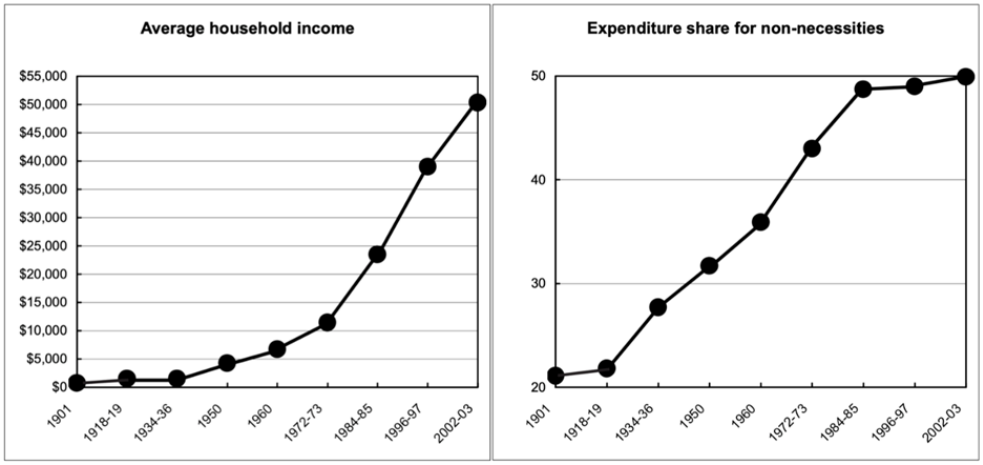

Figure S2: Household Earnings and Spending, 1901-2003

indicative of a sophisticated status. Someone who simply wishes to look wealthy could afford the same outfit as someone who is truly wealthy due to the price of luxury goods relative to income dropping significantly. Designer clothes and a foreign luxury car have come to indicate a standardized style of living, rather than a lifestyle of luxury.

All of these phenomena discussed are apparent in the United States. We will focus on this country for the purposes of our research, as it provides a good example of these phenomena and also has adequate data to base our claims upon. Though this country provides good examples and data, it is far from an exception, as it reflects a common trend seen among many already developed first-world countries.

To understand and explain this phenomenon, we will begin by reviewing the relevant litera- ture that serves as the foundation for our model and thought process. Then, we will move on to formally discuss the model, explaining its objective and design. Following the model, we state our results, and we discuss our findings. Last comes the conclusion, which will tie our original question with the final result and summarize the benefits of our model.

2. Literature Review

The economic modelling of signaling practices began with Spence (1978). In the paper Spence shows that even when costly signals have no inherent value, they can be useful as a method to distinguish oneself from the pack. In the current paper we will expand on and alter the Spence model in order to describe a specific implication of long-term trends in signaling.

Schaeffer (2015) provides evidence that our sense of aesthetics is driven in part by a costly signaling mechanism. While the book focuses on artistic implementations, the same mechanisms immediately follow in the fashion industry. Further supporting evidence is provided by Voland (2003). In this paper we will take it for granted that part of our desire for fashion is driven by a desire to send signals. Furthermore, these signals are received as indicators of wealth or resources.

A similar behavioral phenomenon is explored in Hoffman et al. (2018). We focus on the implications of modesty in fashion as opposed to direct behavioral implications. In particular, we focus on trends that cause changes in equilibria, rather than equilibria selection.

Of course, this section would be incomplete without referencing the size of the fashion in- dustry. A recent report on the industry, Maloney (2015), shows it is quite vast. In the United States alone $380 billion was spent in 2017 on apparel and footwear. Over 1.8 million people were employed by the industry in the United States alone in the same year. Furthermore, the skills utilized by the industry are quite varied, ranging from CAD for prototypes to market research analysts.

3. Model

The objective of this model is to note the interactions between 2 players: a sender and a receiver. The sender will be one of two types: low (l) or high (h). Similarly, the receiver also will

have one of two types: straightforward (f), or sophisticated (p). The model will describe a signaling game, where the sender has the additional option to obfuscate their signal causing it to be missed with positive probability. The game proceeds as follows. Both players privately learn of their type. The sender is a low type with probability pl $\in$ (0,1) and high otherwise. The receiver is a straightforward type with probability pf $\in$ (0,1) and sophisticated otherwise. The sender may choose between sending a low signal, L, a high signal, H, and an obfuscated signal, O, all of which incur a cost according to assumption 1. The receiver then learns of the sent signal, unless it is an obfuscated signal, in which case the straightforward receiver observes a low signal while the sophisticated receiver observes the obfuscated signal. The receiver may choose to accept, A, or reject, R, after observing the sent signal. Formally, the action space of the sender (A_S) and of the receiver (A_R) are as follows:

To describe mixed strategies, we will use the following notation: the straightforward receiver will accept *L* with probability $p^f(L)$, *H* with probability $p^f(H)$, and *O* with probability $p^f(O)$. We use similar notation for the sophisticated receiver, where $p^p(S)$ indicates the probability with which signal *S* is accepted.

We will proceed by defining the utility each sender receives. For both senders, their cost is cs, where s is the signal type. For the low sender, the type of receiver does not matter. Thus, if accepted by either receiver the sender receives $a > 0$, while if rejected, receives 0. This gives an accepted low sender the utility $a - c_s$, and a rejected low sender utility $-c_s$. On the other hand, the high sender holds a strict preference for the sophisticated receiver. Thus, the high sender only receives $a > 0$ when accepted by the sophisticated receiver, and 0 if rejected. If accepted by the straightforward receiver, the high sender receives 0, whereas if they are rejected by a straightforward receiver they receive $r > 0$. Thus, the high sender has a more complex utility.

We assume that the costs incurred for a high or obfuscated signal are the same, both of which are greater than the cost of a low signal.

Assumption 1. $c_o = c_h > c_l > 0$

Next, we define receiver utility. Rather than holding preferences over the senders' types, receivers instead hold preferences over signal types. This is because the receiver receives judgement from their peers based on what type of signal is accepted or rejected, rather than the type of person sending these signals. Thus, both receivers have a utility solely based on whether they accept or reject a certain signal. The straightforward receiver's utility, u^f_s, is equal to either a^f_s or r^f_s, where *a* is acceptance, *r* is rejection, and *s* is the type of signal. We use a similar notation for the sophisticated receiver's utility, u^p_s.

The straightforward receiver seeks to accept whatever they deem to be currently in fashion. By contrast, they will reject whatever they deem to be distinguished. Thus, their utility is high when accepting trendy signals and rejecting distinguished signals, while their utility is low when accepting distinguished signals and rejecting trendy signals. Inversely, the sophisticated receiver seeks to reject trendy signals while accepting distinguished signals. Thus, their utility tends to have the opposite sign relative to the straightforward receiver's utility from a signal.

Additionally, we assume that straightforward receivers cannot distinguish between low or obfuscated signals, namely:

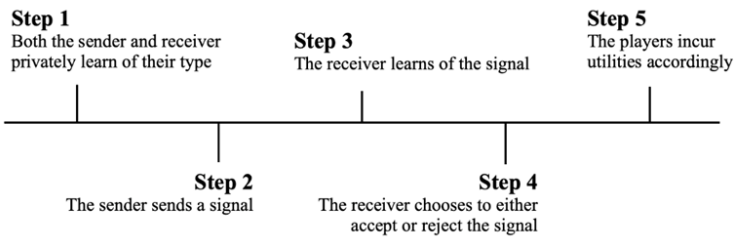

Figure S3: Timeline

Assumption 2. $p^f(L) = p^f(O)$

The timing of the model is summarized in Figure S3.

4. Results

We will show that there exist multiple possible signaling equilibria of this model. As the parameters shift, making signaling cheaper for the sender, the set of equilibrium will shift in response. In particular, we will focus on two strategy profiles and provide justification for why these are the two strategy profiles of interest. In the first, the direct strategy profile, the low sender will send a low signal, the high sender a high signal; the straightforward receiver only accepts low signals, and inadvertently obfuscated signals, while the sophisticated receiver accepts both high and obfuscated signals. In the second strategy profile, the hidden strategy profile, the low sender will send a high signal, but the high sender will now send an obfuscated signal; the straightforward receiver will accept only high signals, and the sophisticated receiver will accept only obfuscated signals.

First, we begin by finding conditions under which the direct strategy profile is an equilibrium. We provide intuition for the results that follow. In order to do so, we proceed player by player describing their implied course of play.

Consider the low sender. The low sender may choose to abstain from signaling for many reasons: costs of maintaining their signal, risks of being targeted by fellow senders due to their signal, or risk of damaging their signal, just to name a few. We show that under certain assumptions, in equilibrium, the low sender always sends a low signal. To justify the above, we assume:

Assumption 3. $p_f > p_p$, $u^f_l > 0 > u^f_h$ *and* $c_h - c_l > p_p * a$

Lemma 1. *Under assumption 3, in any perfect Bayesian equilibrium:* $p^f(L)=1$, $p^f(H)=0$

Proof. Consider the straightforward receiver's decision upon observing a low signal. Assumption 3 implies that accepting low signals is a strictly dominant action, yielding utility $u^f_l > 0$. Therefore, the receiver must always accept, implying that $p^f(L) = 1$ in any Perfect Bayesian Equilibrium. Similarly, rejecting high signals is also a strictly dominant action; therefore, pf(H)=0 in equilibrium as well.

Assumption 4. $u^p_o = u^p_h > 0 > u^p_l$, $p_p * a + p_f * r - c_h > -c_l$

Lemma 2. *Under assumptions 4, in any perfect Bayesian equilibrium:* $p^p(H) = p^p(O) = 1$, $p^p(L)=0$

The proof of lemma 2 is omitted, as it follows under logic identical to that in the proof of lemma 1. Assumptions 3 and 4 are representative of trends in societal life in the early 1900s. In this time period, the percentage of those who sought trendy signals, or straightforward receivers, was much higher than the percentage of those who sought distinguished signals, or sophisticated receivers, implying our assumption $p_f > p_p$. In this parameter region, it follows that the low sender would prefer to choose their signal based on the preferences of the straightforward receiver, since they were the more abundant receiver. The straightforward receiver, as previously noted, sought trendy items. In these times, luxury goods were out of the reach of many, so trendy items focused on style rather than status. Since they tended to be more affordable and reasonably priced items, they were well represented by the low signal.

High signals were not sought by the masses due to their high price and limited access, and there was no need nor recognition for obfuscated signals, due to the high signal already being unfamiliar to many. Taken together, the motivation for many to opt for lower signals and their resulting popularity made these signals the ideal trendy signal, generating the utility ordering of the straightforward receiver, $u^f_l > 0 > u^f_h$. If the low sender sent a high signal, lemma 1 implies that the straightforward receiver would reject them. Since $p_f > p_p$, high signals yielded strictly lower utility for a low sender, due to a lower cost of acceptance and higher signal cost. As such, the low signal was the optimal strategy for a low sender.

For a high sender, the type of receiver was much more important. In sending their signal, the high sender hoped to garner approval from the sophisticated receiver, while avoiding the favor of the straightforward receiver. In practice, this

could be indicative of a high sender potentially looking to set up a business deal with a sophisticated receiver, or marry into a sophisticated receiver's family. The high sender recognizes that there is much to be gained from a relationship with a sophisticated receiver, whereas a straightforward receiver may not have as much to offer. Last, we must consider the sophisticated receiver's preferences. At the time, since low signals were trendy, high signals were sufficient to distinguish individuals. These high signals were luxury goods that were certainly a sign of distinction to sophisticated receivers. Since high signals were definitively a sign of distinction, there existed no need to further distinguish by sending the obfuscated signal, though they would have been accepted if sent. As a result, under this parameter region, the high sender sends a high signal; its high chances of rejection by the straightforward receiver and of acceptance by the sophisticated receiver justify this choice.

Proposition 1. *When assumptions 3 and 4 hold, the direct strategy profile is an equilibrium.*

Proof. We begin by assuming all players are utilizing the direct strategy profile. We then consider each player's incentive to unilaterally deviate. First, the low sender currently receives a utility of $p_f * a - c_l$ from sending a low signal and being accepted by the straightforward receiver and rejected by the sophisticated receiver. The low sender could deviate and send a high signal, but doing so yields strictly lower payoff than sending an obfuscated signal, due to its certain rejection by the straightforward receiver with an equivalent cost. Through sending an obfuscated signal, the low sender would be accepted by both receivers. The utility from this would be $a-c_h$ relative to the previous utility of $p_f a-c_l$. Subtracting the second from the first yields $p_p a + (c_l - c_h)$. Assumption 3 then implies that this deviation decreases the low sender's utility. As such, the low sender has no incentive to deviate.

Next, we consider the high sender. The high sender's utility is $p_f r + p_p a - c_h$, as they are rejected by the straightforward receiver and accepted by the sophisticated receiver. The high sender could deviate and instead send a low signal. Doing so would produce results in contradiction to their goal, as the straightforward receiver would accept the low signal while the sophisticated receiver would reject. To be exact, their utility would be $-c_l$. Subtracting the two yields $p_f r + p_p a + c_l - c_h$; assumption 4 implies that this is not profitable. Alternatively, the high sender could send the obfuscated signal. Both receivers would accept the signal, again yielding an overall lower utility, $p_p a - c_h$.

For the receivers, the choice is not nearly as complicated. Lemma 1 implies that the straightforward receiver has no beneficial unilateral deviations. Similarly, lemma 2 implies that the sophisticated receiver is also playing optimally.

Second, we find conditions under which the hidden strategy profile is an equilibrium.

Assumption 5. $u^f_h > 0 > u^f_l$, $u^p_o > 0 > u^p_l = u^p_h$, $p_f a > c_h$, $p_p a > c_h$

As time goes on, values change. In the modern day, brand names take precedent over style. What is now in fashion is not what type of attire one has, but rather who created said attire. These creators, or brands, represent high signals, as they are what were previously deemed luxury items. Though they are still items of luxury, the new standard of living, as referenced in Figure S2, creates a wealthier average person, increasing the accessibility of said signals. Thus, they have become widespread and popular, with more people able and willing to purchase and recognize them. We recognize that the relative costs are not impacted by these changes; they remain comparatively the same, with $c_o = c_h > c_l$. While their exact values may have changed, these luxury items are still more expensive than their counterparts.

Taken together, these observations create the new inequality $u^f_h > 0 > u^f_l = u^f_o$. Consequently, the sophisticated receiver must also change their preferences, as high signals are no longer distinguished, but are instead rather common. Desiring a new method of distinction, the sophisticated receiver looks to the less common obfuscated and low signals. However, low signals were still trendy only up until recently, and they do not indicate wealth, making them an

undesirable candidate. Thus, the following inequality describes the sophisticated receiver's new preference for obfuscated signals: $u^p_o > 0 > u^f_l = u^f_h$.

It should be noted that there is no relative change in the populations of the receivers. Trend- seekers are still common, while those who seek distinguished items are still the minority. Thus, the inequality $p_f > p_p$ holds.

Lemma 3. *In any perfect Bayesian equilibrium:* $p^f(H) = 1, p^f(L) = p^f(O) = 0$*;* $p^p(O) = 1, p^p(L) = p^p(H) = 0$

Proof. While the chance of encountering each receiver does not change, there is a change in each of the receiver's preferences. Due to the new trend of sending high signals, the straightforward receiver's probability of accepting a high signal increase. Furthermore, the straightforward receiver sees no incentive to deviate from their trendy signal and will thus choose it every time, making $p^f(H) = 1$, and thus, $p^f(L) = 0$. As a result, the sophisticated receiver opts for the distinguished obfuscated signal, and seeing no reason to deviate, creates the new equality statements of $p^p(O) = 0$ and $p^p(L) = p^p(H) = 0$.

Proposition 2. *When assumption 5 holds, the hidden strategy profile is an equilibrium.*

Proof. With these new parameters, a hidden equilibrium is revealed. We first consider the low sender and their previous strategy of sending the low signal. Since the straightforward receiver remains the more common receiver, the low sender tailors their strategy to the straightforward receiver's preference, which is the trendy high signal. Furthermore, since $p_f a > c_h$, the low sender will certainly choose to send a high signal, as doing so will yield a positive utility. If the low sender considers the obfuscated signal, it will certainly be rejected by the straightforward receiver, but will be accepted by the sophisticated receiver, yielding utility $p_p a - c_o$, which is a strictly lower utility due to the sophisticated receiver being less common. If the low sender instead attempts to send a low signal, neither the straightforward nor sophisticated receiver will accept the signal, yielding a utility of $-c_l$. In both cases, the payoff for the low sender is strictly lower, giving no incentive to deviate.

Next, we consider the high sender, who still wishes to garner the approval of the sophisticated receiver while avoiding the favor of the straightforward receiver. The high sender first considers the straightforward receiver, as they are the more common receiver. They are certain to reject both low and obfuscated signals, so to choose between the two signals, the high sender now con- siders the sophisticated receiver. The sophisticated receiver is certain to choose the obfuscated signal, making the obfuscated signal the optimal choice with utility $p_f r + p_p a - c_o$. If the high sender weighs the option of sending a low signal, both receivers will reject, yielding the utility $p_f r - c_L$, a lower utility than before. When a high signal is considered, the straightforward receiver will accept while the sophisticated receiver will reject, resulting in the exact opposite of the high sender's desired results, with utility $-c_h$.

Both receivers have no incentive to deviate, as proved in lemma 3.

When analyzing propositions 1 and 2, we see that they produce results that are historically accurate. Before the advent of brand names, trends were often determined purely by style, with the according attire tending to be both easily accessible and of affordable cost. This truth is reflected in proposition 1, where low senders sent low signals, which appealed to the trend-seeking masses. This allowed the wealthy to show off their money by buying any expensive brand name without consequence, as they were all valid forms of distinction, appealing to those with distinctive tastes while being rejected by those with trendy tastes.

As brand names began to proliferate, the changes that followed are reflected in proposition 2. The pricey brand name attire became common among the masses, leading to a new trend that valued brand names, meaning common brands were no longer a sign of distinction. As a result, those with distinct tastes began rejecting these brands, leading wealthy individuals to opt for the new sign of distinction: the obfuscated signal. These items of hidden luxury were

lesser known, yet still pricey brand names. As a result, more common brand names have turned to the modern phenomenon of simplifying their logos. In doing so, they are able to compete with lesser known luxury brands for the attention of wealthy consumers, as a simpler logo is less likely to be noticed by the common eye, thus making it a more suitable indication of distinction. Next, we show that changes in the proportions of receivers can also cause such a shift in equilibria from proposition 1. The progressive push for ideals such as embracing individuality and distinction is becoming increasingly common in the modern day. In conditions such as these, it is plausible for more and more individuals to begin to appreciate distinguished signals, potentially leading to a new situation where the sophisticated receiver is more common. In this scenario, there is no incentive for the sophisticated receiver to deviate from their strategy of accepting both high and obfuscated signals, as fashion has not changed. Similarly, the straightforward receiver also has no reason to change their strategy. The fashion has not changed, meaning low signals are still trendy. Thus, the straightforward receiver sticks with their strategy of accepting the low signal, and inadvertently the obfuscated signal, while rejecting the high signal. However, due to the increased presence of sophisticated receivers, the incentive for low senders to send costly signals is increased.

Proposition 3. *When $u^f_l > 0 > u^f_h$, $c_h - c_l < p_p a$, and $p_p > p_f$, the following strategy profile is an equilibrium. The low sender sends an obfuscated signal, the high sender sends a high signal, the straightforward receiver accepts only low signals, and the sophisticated receiver only accepts high or obfuscated signals.*

Proof. $p_p > p_f$ implies that both senders will first consider the sophisticated receivers prefer- ences, as they are now the more common receiver. Since the parameters of lemma 1 and 2 hold, neither receiver has any profitable deviations. The senders' goals have not changed: the low sender wishes to be accepted with as high a probability as possible while the high sender wants to be accepted only by the sophisticated receiver.

To achieve their goal, the low sender begins by considering the more common sophisticated receiver. Since the sophisticated receiver accepts both the high and obfuscated signal, the low sender considers both signals and looks to the straightforward receiver to finalize this decision. Since the straightforward receiver will accidentally accept obfuscated signals, mistaking them for low signals, the low sender opts to send the obfuscated signal, yielding utility $p_p a + p_f a - c_o$, which simplifies to $a - c_o$ since $p_p + p_f = 1$. While this result was rejected previously in proposition 1, it is now the optimal result because $p_p > p_f$. The previous equilibrium where the low sender sends the low signal is no longer valid, as it will yield utility $p_f a - c_l$, which is now a lesser utility because the value of p_f is lowered. Finally, we consider the high signal, which will yield utility $p_p a - c_h$. While this mimicked the low signal's situation in proposition 1, the matching costs of the obfuscated and high signal make it a strictly lower utility, as $p_p a < p_p a + p_f a$.

Similarly, the high sender also considers the sophisticated receiver first. Seeking the sophis- ticated receiver's acceptance, the high sender will also consider both the high and obfuscated signal. To choose between the two signals, the high sender now considers the straightforward receiver, from whom they seek rejection. The straightforward receiver only rejects high signals, making the high sender's choice clear: send the high signal, which yields the highest utility $p_p a + p_f r - c_h$.

These results are somewhat unexpected, as the low sender is in a position where it is optimal for them to send the obfuscated signal. In a world where distinction is valued, as presented in this scenario, the masses will move to obfuscate their signals while wealthy individuals will see no change. However, since it is the masses that choose the obfuscated signal, it is only natural that the signal will become more prevalent and less distinct, creating a need for further distinct signals, as seen in the shift from the high sender and sophisticated receiver's switch from high to obfuscated signals in proposition 2. Thus, we

envision a scenario where many new brands are able to compete by offering distinct products, while existing brands must constantly shift styles, logos, and image to keep up with the ever-changing times.

In a separate scenario, we consider the time between the change in the receiver's preferences. It is highly unlikely that both receivers would simultaneously change their preferences, so we consider the impact of one receiver opting to change their strategy. In this hypothetical, we examine what would occur if the straightforward receiver's utility were to change.

Proposition 4. *When $a - c_h > -c_l$, and assumptions 3 and 4 hold, with the exception of u^f_h and u^f_l , the following is true. When u^f_h is decreased and u^f_l is increased, both receivers' preferences and both senders' actions hold. However, if u^f_h is increased and u^f_l is decreased such that $u^f_h > 0 > u^f_l$, the straightforward receiver will reject low signals and accept high signals, while the sophisticated receiver remains constant in their preferences according to lemma 2. As a result, the low sender will send high signals, while the high sender will send obfuscated signals.*

Proof. When u^f_h is decreased and u^f_l is increased, none of the players have an incentive to change their strategy described in proposition 1. The straightforward receiver's utility already implies that $u^f_h < 0 < u^f_l$, so by decreasing u^f_h while increasing u^f_l, u^f_l remains the better option. Thus, the straightforward receiver's optimal responses are not changed. Since changes in u^f_h and u^f_l do not have an impact on the sophisticated receiver, their strategy does not change either. However, when u^f_h is increased and u^f_l is decreased to the point that $u^f_h > 0 > u^f_l$, the straightforward receiver, and thus other players, will change their strategy, creating a new equilibrium. Firstly, the straightforward receiver will begin to accept high signals while rejecting low signals, as high signal utility has become positive, while low signal utility has become negative. On the other hand, the sophisticated receiver remains unchanged. However, both senders must now change their strategy according to the straightforward receiver's new preferences.

The low sender first considers the straightforward receiver, as they are the more common receiver. Seeing that the straightforward receiver will only accept high signals, the low sender initially only considers high signals. Their choice is confirmed when considering the sophisticated receiver, who accepts both high and obfuscated signals. Since both receivers accept high signals with probability 1, the low sender will only send high signals, yielding utility $p_f a + p_p a - c_h$, which simplifies to $a - c_h$ because $p_f + p_p = 1$. If the low sender were to consider sending an obfuscated signal, it would yield utility $p_p a - c_o$, which is strictly lower than a high signal since $p_p < p_p + p_f$, while the cost is the same. When considering a low signal, the low sender will receive negative utility $-c_l$, as both receivers will reject the low signal. Since $a - c_h > -c_l$, the low signal is also not the optimal signal.

Now we examine the high sender, who will also consider the straightforward receiver's preferences first. Desiring rejection from the straightforward receiver, the high sender considers both the low and obfuscated signal, which are both certain to be rejected by the straightforward receiver. To narrow down their choices, the high sender then considers the sophisticated receiver. Since the sophisticated receiver will accept both high and obfuscated signals with probability 1, the high sender will send the obfuscated signal, yielding utility $p_f r + p_p a - c_o$. The low and high signals will yield lower utilities $p_f r - c_l$ and $p_p a - c_h$, making the obfuscated signal the optimal choice.

Corollary 1. The strategy profile described in proposition 4 is the unique perfect Bayesian equilibrium given the assumptions of proposition 4.

Proof. To prove this, we examine each player's choices. Since u^f_l is negative while u^f_h is positive, there is no other optimal strategy for the straightforward receiver than to accept high signals and reject low signals in a perfect Bayesian equilibrium. On the other hand, since 2 holds true, the sophisticated receiver sees no reason to accept low signals, and will instead accept both high and obfuscated signals.

The low sender would resume sending high signals, as it will still be accepted by both receivers. Sending a low signal, yields to complete rejection, and $a - c_h > -c_l$ implies high signals are more profitable.

The high sender will continue to consider the straightforward receiver, and will conclude that they wish to send either low or obfuscated signals, as both will be rejected by the straightforward receiver. Notably, the high signal yields lower utility than the obfuscated signal as it triggers acceptance by the straightforward receiver. Thus, the high sender will send the obfuscated signal, as $p_f r + p_p a - c_h > p_f r - c_l$.

Therefore, all players have a unique strategy in equilibrium, and it follows that the resulting equilibrium is unique among perfect Bayesian equilibria.

Next, we examine what would happen if the sophisticated receiver were to change their preferences first. In this case, we do not explore the possibility of change in utility of the low and obfuscated signals. Being the indicator of both distinction and sophistication, there would not be a case where the sophisticated receiver would prefer the low signal, as it would be deemed unsophisticated by the sophisticated receiver's peers. Similarly, there does not exist an instance where the sophisticated receiver would not accept obfuscated signals, as they are always a sign of distinction. The argument can be made that if the majority of senders begin sending obfuscated signals, then the sophisticated receiver would have to reject them, as they are indicative of a trend. However, if this were the case, the obfuscated signal could no longer be called as such, as it loses its function of being obscure.

We must also further specify the preferences of the high sender; specifically, the value of rejection by the straightforward receiver as opposed to the value of acceptance by the sophisticated receiver. While the high sender wants to avoid association with the straightforward receiver, they would rather risk that chance multiple times in order to end up with a sophisticated receiver than to never associate with a sophisticated receiver at all. This situation equates to an individual seeking a sophisticated partner; they would rather endure multiple relationships with straightforward partners in order to end up with a sophisticated partner, instead of never attempting to mate and ending up alone.

Proposition 5. *When assumptions 3 and 4 hold, with the exception of u^p_h, $p_p a > p_f r$, and $p_p a > c_h$, the following is true. When u^p_h is increased, the sophisticated receiver's strategy, and thus the remaining players' strategies, will not change. However, when u^p_h decreases to the point where $u^p_h < 0$, the sophisticated receiver will no longer accept high signals, creating a new equilibrium. The sophisticated receiver only accepts obfuscated signals, the straightforward receiver accepts low, and thus obfuscated, signals, the low senders send low signals, and the high senders send obfuscated signals.*

Proof. First, we consider the situation where u^p_h is increased. In this case, the sophisticated receiver sees no incentive to change strategy, as u^p_h was already positive and would bring the receiver a positive utility either way. Thus, none of the other players change their strategies.

However, when u^p_h is decreased to the point where $u^p_h < 0$, the sophisticated receiver's strategy changes. Since u^p_h is no longer a positive utility, the sophisticated receiver will no longer accept high signals. The straightforward receiver 's preferences hold.

Since the sophisticated receiver's strategy changes, the senders change accordingly. A low signal captures only the straightforward receiver, while an obfuscated signal capture both. Last, a high signal causes rejection by both receivers. In particular, since assumption 3 implies $a - c_h < p_f a - c_l$, the low sender prefers to send a low signal to an obfuscated signal.

On the other hand, the high sender now prefers to send a high signal. The obfuscated signal would yield utility $p_p a - c_h$. Sending a high signal yield utility $p_f r - c_h$. Since $p_p a > p_f r$ the high sender prefers the obfuscated signal to the high signal. Sending the low signal would yield a lower utility $-c_l < 0 < p_p a - c_h$, as the straightforward receiver will accept their signal while the sophisticated receiver will reject.

To describe the implications of propositions 4 and 5, we would like to compare the resultant actions of the high and low senders in each scenario. While the high sender sent obfuscated signals in both situations, an interesting difference is seen in the actions of the low sender: they send high signals in proposition 4 and low signals in proposition 5. When analyzing these outcomes, proposition 4 seems more in line with what would occur in the real world. Intuitively, it makes sense. Low senders begin sending high signals, indicating a new trend, leading to sophisticated receivers rejecting said signals, ultimately resulting in the optimal strategy for high senders being to send obfuscated signals. This also makes sense analytically; it matches the outcome of proposition 2, which is based off of what has recently occurred in the United States. On the other hand, proposition 5 creates an unlikely scenario. If low senders send low signals, it does not make sense for high senders to opt for obfuscated signals, as the high signals still serve to distinguish them from low senders. Further, it is also improbable that the sophisticated receiver would choose not to accept high signals in this case. Accepting high signals would be of no detriment as they would still indicate a distinctive style, serving to widen their range of acceptance while retaining their personal tastes.

Thus, we rationalize that proposition 4 is closer to what we observe in the real world; not only does it make intuitive sense, but it also matches the evidence of what has historically occurred. Therefore, the assumptions behind this proposition are likely to be more accurate than those in proposition 5. This could potentially mean that the masses are the ones who drive changes in signaling. When wealthier individuals opt for new fashion choices, it is reasonable to say that it is merely a result of attempting to move away from the common choice. This also makes sense intuitively, since without changes in the preferences of many, distinct signals cannot lose their distinction.

We want to emphasize that all of the above results are not dependent upon specific signal cost assumptions. Rather, they hold for a broader class of parameters. In the following proposition we show that the assumption regarding the equality of the cost of the high and obfuscated signals is not necessary for our results, so long as the cost of the obfuscated signal is not too large.

Proposition 6. There exists $C>c_h$ such that when assumptions 3 and 4 hold, but assumption 1 is changed such that $C>c_o > c_h > c_l > 0$, the hidden strategy profile remains an equilibrium.

Proof. First, we consider the receiver's preferences. Their goals have not changed, and neither have the fashion choices; thus, their preferences remain according to lemmas 1 and 2. Low signals are still trendy, making them desired by the straightforward receiver, while high signals are still distinguished, making them desired by the sophisticated receiver.

Now we consider the senders, whose goals have not changed either. The low sender still wishes for acceptance, regardless of the receiver, while the high sender still only wants to be accepted by the sophisticated receiver. The low sender first considers the straightforward receiver's preferences, as they are still the more common receiver. Knowing that the straightforward receiver accepts low or obfuscated signals, the low sender considers both signals and looks to the sophisticated receiver to confirm their decision. Since the sophisticated receiver will only accept high signals, they do not narrow down the low sender's choice. Thus, it comes down to the cost between the low and obfuscated signals, as their chance of acceptance are the same. Thus, the low sender considers utilities $p_f a - c_l$ *and* $p_f a - c_o$. Since $c_l < c_o$, $p_f a - c_l$ yields the highest utility. To ensure the low signal as the best choice, the low sender considers the high signal. Sending the high signal yields a strictly lower utility $p_p a - c_h$, as it incurs a higher cost while having a lower chance of acceptance, confirming the low sender's choice of the low signal.

Next, the high sender will also consider the straightforward receiver first. Desiring rejection, the high sender considers the high signal, which has no chance of acceptance by the low sender. In order to confirm this choice, the high sender

now considers the sophisticated receiver. By 2, the sophisticated receiver prefers the high signal. Thus, because of its sure chance of rejection by the straightforward receiver and acceptance by the sophisticated receiver, the high signal is chosen, giving utility $p_f r + p_p a - c_h$. The high sender could weigh their other options of the obfuscated and low signals, but doing so would yield the utilities $p_f r + p_p a - c_o$ and $p_f r + p_p a - c_l$, respectively, which simplify to $-c_o$ and $-c_l$, which are strictly lower than the high signal utility.

5. Conclusion

In this paper, we consider a model of fashion signaling. We focus on a mechanism that considers the incentives of senders and receivers in the fashion world. In analyzing the model, we compare equilibria under several parameter regions in order to determine when obfuscated signaling will or will not arise. Notably, we show that the tastes, or costs, of the common sender changing may drive another change in the tastes of discerning receivers yielding obfuscated signaling in equilibrium.

However, the reverse sequence, where changes in sophisticated receiver tastes generate changes in straightforward receiver tastes, does not match the evidence in the real world. This provides several implications for those who wish to predict fashion trends. For example, while the objective may be to maximize profit from the highest priced line, this objective may be better served by tracking cheaper trends.

Similarly, another implication of the model is that an increase in demographic level income will naturally lead to obfuscated signals. As it becomes relatively less expensive to purchase signals, they become a weaker signal of quality. As such, it drives discerning individuals to find another method of distinguishing themselves. Obfuscated signals provide a natural method of doing so, which we show is consistent with observed trends in the real world.

A question that naturally arises as one examines the model is the question of why signaling is obfuscated. Instead of purposefully hiding signals, why don't wealthy individuals simply buy items that are out of the price range of many? While that may initially seem like the appropriate response, ostentatious shows of wealth attract the attention of all, not simply other wealthy individuals. We must keep in mind that for these "high senders," their main objective is to facilitate association with those of a luxurious status. Displaying one's wealth clearly, such as with an extravagant purchase of multiple yachts, does not selectively appeal, but instead appeals to all. While it may attract others of a luxurious status, it is equally likely to garner the praise or recognition of individuals with whom the sender does not wish to associate. Through utilizing obfuscated signals, senders are able to avoid this problem. Obfuscated signals only appeal to the discerning eye, meeting wealthy individuals' objective of association with other wealthy individuals, while avoiding the problem of mass appeal.

This paper leaves open avenues for more applied research. In particular, it would be interesting to observe the results of a regression of median income upon a measure of hidden signals. While lab or field studies would provide difficulties in interpretation, broader demographic level studies could provide suggestive evidence.

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