A Model for Trust Driven Advertising

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Abstract: Cognitive processes underlie economic relations. In this paper, we develop a conceptual, mathematical, and computational framework for modeling market exchange as a series of dynamically interacting cognitive processes. Specifically, we show how advertisers can build trust and gain confidence in their pricing power to the point that they erode trust and undermine the efficacy of their advertising. Customers conversely orient towards advertisers seeking information or turn away from them as unreliable communicators. These behaviors and the patterns they generate occur inside a state space of unallocated perceived value. They constitute a small subset of the full range of possible strategic and adaptive responses that define cognitive microeconomics.

1 Introduction

The principle that market exchange creates value is one of the foundations of economics. Evidence of trade in ochre crayons goes back around 300,000 years, to the beginning of our species (Brooks et al., 2018). The basis for a market exchange is that two parties assign asymmetrical value to a good (Smith, 1776). Yet the value assigned to the good by the seller relative to the cost is not necessarily a simple inverse of the value assigned to the good by the buyer relative to the cost; the asymmetry is often much more favorable to both parties.

As a first approximation, we can use the labor theory of value (Ricardo, 1821) to define the state space of win-win solutions. Consider a skilled flint knapper that makes five serviceable hand axes in a day, while it takes his hunter neighbor a day of work to hunt an animal, skin it, and prepare the pelt; each has a competitive advantage (Ricardo, 1821). Say the hunter would have to spend two days to make a single axe and the knapper two days to acquire a single pelt, creating a large unallocated value residual within the price equilibrium. For instance, if they agree to exchange a pelt for five axes, the hunter gets a value residual of five days' labor and the knapper a value residual of one day's labor. How does the market allocate this surplus value? All points within this space are in principle acceptable, as they would result in a net benefit to both parties.

Consider a product with twenty dimensions of value, from packaging to color, shelf-life to hipness. Winterfeldt and Fischer describe that for each of these dimensions, we can attach a cost of materials and labor; the sum of these represents the production cost to the manufacturer (Von Winterfeldt and Fischer, 1975). Similarly, for the customer to reproduce each of these qualities would require some cost, in many cases far exceeding production costs. The difference between these two arrays represents at once a value residual and a field of win-win solutions for trade. In an industrial society, most of the surplus value is created by machinery fueled by external energy; human labor represents only a fraction of the cost. This leaves plenty of surplus value to be divided among producers and consumers.

We propose that this value residual is fundamentally unallocated by the market. No laws of economics determine how the value residual, or surplus value (Marx, 2020), is divided between the two parties in a market exchange, or between producers and customers. The value residual could be magnanimously given away or taxed to finance a state; in the following, we aim to show how it can give rise to a complex dynamic of value and trust.

In summary, we propose that market exchange

relations are characterized by the creation of multidimensional state spaces of prospective value in which actors navigate based on imperfect information. Value spaces are viewpointed and need to partially overlap to enable cooperative markets. Surplus value is an expected feature of such transactions and its allocation is not determined by market forces alone. Instead, the value differential constitutes an open space where the participants navigate in an adaptive decision process we may term "wayfinding" (McCubbins and Turner, 2020).

2 Communicative Potential

The residual value represented by the difference between actual production costs by the manufacturer and the hypothetical production costs by the customer creates a communicative potential, expressed through the medium of advertising. On the one hand, prospective buyers need information about the products and services available in the market to decide whether to make a purchase. On the other hand, sellers have an incentive to provide relevant information about their product or service to persuade customers to purchase it.

In this communicative act, which in the case of advertising is typically a one-way street from advertisers to prospective customers, we propose that the two parties are competing to capture a share of the residual value. In efficient markets, the market price of a good will tend to move towards the production cost, in effect allocating the lion's share of the residual value to the customer. In the present model, advertising is a tool the producer uses to contest and attempt to recapture some of this value.

We propose the communicative potential as a holistic concept that incorporates the expressive potential of the advertiser as well as the receptive potential of the customer. We will explain how this communicative potential is dependent on the customer's cost of acquiring information and the degree to which they trust that information. Through the development and implementation of our dynamical model, we seek to understand how these potentials are related and which dynamics describe their intertwined trajectories.

2.1 Expressive and Receptive Potentials

Our starting point is the observation that communication is costly. On the part of the advertiser, this cost is expressive: how should the ad be formulated linguistically and visually, in which channels should it be transmitted, and at what times and frequencies? For the advertiser, the rate of return per ad matters: if a campaign does not result in increased sales, it may be a losing proposition to continue to increase the advertising budget. On the part of the customer, the cost is receptive: what is the information I need to make a decision, where can I find that information, how difficult will it be to collect it? The communicative dynamics arise in how these latent potentials engage with each other.

In order to prepare yourself for acquiring information, you need to free up your mind from competing concerns; you also need to activate the appropriate interpretive frames. This cognitive activation has a small but potentially significant metabolic cost; your brain is consuming sugars and oxygen and will at some point need rest to recover. By activating a certain cognitive frame, you selectively enhance your ability to gather certain types of information, but at the same time reduce your ability to acquire unrelated types of information. In this way the creation of a receptive potential imposes not only a cognitive and metabolic cost, but also an opportunity cost.

Moreover, your decision to prepare a targeted receptive potential carries a certain amount of uncertainty and risk. You must necessarily allocate resources to listen before you know what you are going to learn. Before you actually hear what the advertiser is going to say, you cannot know with certainty that the message is going to be informative along any of the dimensions you may be interested in. Let's consider a product that has twenty relevant dimensions of quality and functionality, from color and shape to expected lifetime and warranties; as a prospective customer, you may be searching for information regarding only five of these, and you cannot know beforehand that information relevant to your search will be provided. This uncertainty and risk adds to the cost of attention by creating a functional instability in the receptive potential.

The unavoidable cost associated with the creation of a receptive potential means that it's rational to be discriminative in gathering information (Daugherty et al., 2018), for instance by allocating a finite portion of available resources to the task, monitoring the unfolding act of communication, and extending or terminating the interaction according to a running assessment of the achieved and prospective costs and benefits.

3 Dynamics of Trust

3.1 Generation of Trust

The decision to allocate resources to the task of collecting information delivered through an advertisement is modulated by trust. Consequently, we must ask, how is trust generated? A simple way to model this is to say that trust is generated when a given allocation of attentional resources results in acquiring information that produces a coherent action. That is to say, we use information to guide our behavior, and trust is produced when the information provided allows us to guide our behavior so that our intentions are successfully realized. In a marketing interaction, let's say a prospective customer (a "prospect") has some initial interest in a product and is willing to allocate a modest attentional budget to an advertiser. The advertiser provides some information about the product and the prospect extracts some interpretation from this communicative act that results in a a set of expectations and intentions regarding the product. If these exceed some threshold of available resources and perceived net benefit, the prospect decides to purchase. If the product fulfills the prospect's expectations, as formed by the advertisement, trust is generated (Ogilvy, 1985). If you watch the ad for a smartphone and buy it, and you discover all kinds of features you like that you weren't even expecting, we have a situation of an "upside surprise"; in this case, goodwill is generated, a positive credit. This type of trust generation is described by Fung and Lee as an iterative process in which a customer must consistently evaluate whether the information acquired resulted in a successful interaction (Fung and Lee, 1999).

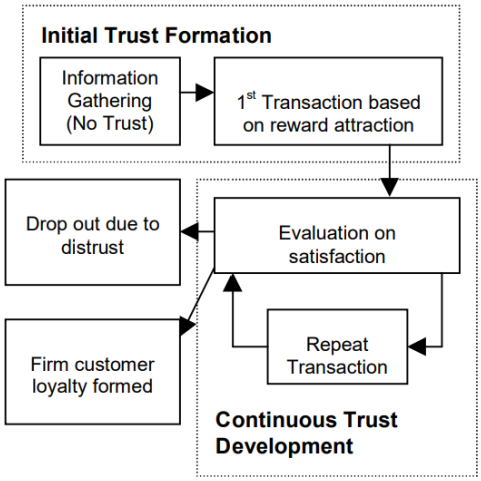

Figure 1: Fung & Lee Trust Development Cycle

3.2 Abuse of Trust

Just as trust can be produced and leveraged in social processes in other domains (Bednar and Page, 2021), advertisers can both produce and leverage trust. Having built a trusting relationship with their customers, advertisers can also behave in ways that leverage and potentially deplete goodwill and undermine trust. They may be motivated to do this in order to solve local problems; for instance, they may be trying to break into a crowded market already dominated by other players. Or they may be trying to introduce new products that haven't been fully tested or to increase profit margins.

Consider a company that has been engaging in producing trust by creating advertisements that honestly communicate the qualities and functionalities of a product and have successfully built trust. They might be tempted to leverage this trust by creating advertisements that exaggerate the benefits of the product. The prospect will attend to this ad, trustingly take it to be reliable, purchase the product, and be disappointed by its qualities. This will erode trust. While the advertiser may not be able to detect the loss of trust directly, it acts as a latent variable that can be inferred from observable behavior, such as the degree of responsiveness to ads (Hopkins, 1923).

4 Dynamical Model

As described above the primary factors that drive the advertiser-customer dynamics are the customers' trust in the advertisement and the cognitive cost trade-off associated with acquiring information from an advertisement. In modeling this dynamic we propose the following iterative system.

$$\tau = \text{Purchase Cycle} \tag{1}$$
$$N = \text{Terminal Purchase Cycle} \tag{2}$$
$$E(\tau) = \text{Expected Value} \tag{3}$$
$$A(\tau) = \text{Advertisement Count} \tag{4}$$
$$T(\tau) = \text{Trust} \tag{5}$$
$$P(\tau) = \text{Advertised Value} \tag{6}$$
$$\beta = \text{Experiential Value} \tag{7}$$
$$\alpha = \text{Expected Value per Unit of Trust} \tag{8}$$
$$\gamma = \text{Price Response Speed} \tag{9}$$
$$n = \text{Memory} \tag{10}$$

$$\sigma(z) = \frac{1}{(1+e^{-x})} - 1/2 \tag{11}$$

$$\mu(\tau) = \sigma(\frac{1}{n}\sum_{i=\tau-n}^{\tau-1}(\beta - P(\tau))) \tag{12}$$

$$A_e(\tau) = \frac{\gamma(A_c(\tau) - A_c(\tau-1))}{2\max(A_c(\tau), A_c(\tau-1))} \tag{13}$$

E, T, P are all initialized with initial values E_o, T_o, P_o, and all variables defined above are logical values.

Algorithm 1 Dynamical Model

for τ = *(1,2,3,...,N)* **do**
  $A_c = 0$
  while $E(\tau) < P(\tau)$ **do**
    $E(\tau) = E(\tau) + \alpha T(\tau)$
    $A_c(\tau) = A_c(\tau) + 1$
  end
  $T(\tau) = T(\tau-1) + \mu(\tau)$
  $P(\tau) = P(\tau-1) - A_e(\tau)$
  $E(\tau+1) = \beta T(\tau)$
end

4.1 Model Explanation

First, we acknowledge that other factors such as monopolization may impact buying behavior. For example if a company has created an ecosystem around their product than customers will have less perceived flexibility to change their buying behavior. Other factors like social class, gender, and life style play a major role in a customers purchase behavior. Even a company's ability to gradually improve the quality of their product can have an impact on a customer's purchase behavior.

However for the purpose of this simulation we begin with a few assumptions. First the advertiser creates a product with invariant experiential value β. In other words the quality of the product does not change. Next the customer has a tendency to purchase the product but has the flexibility to choose not to purchase the product. Take for example the BIC ballpoint pen, a product that customers tend to purchase but have the option to choose other pens on the market. Its also a product whose design and quality has not changed in over 50 years, As a result the advertiser is capable of only two distinct actions. First, increasing a customer's expected value of the product through repeated advertisements or adjusting the price of the product in order to catalyze a purchase.

At each purchase cycle τ_n, the advertiser enters an advertisement cycle where the customer is inundated with advertisements, counted within the variable A_c. After each advertisement, the customer's expected value $E(\tau)$ of the product is nudged closer to the advertiser's proposed value $P(\tau)$ at a rate of α, and in direct relation to the customer's trust in the advertisement $T(\tau)$ (Mitchell and Olson, 1977). If trust is low, then each advertisement will naturally be less effective in nudging the customer's expected value. In this way, the advertiser captures more of the surplus value. Once the gap between the customer's expected value $E(\tau)$ and the advertiser's proposed value $P(\tau)$ is closed, the customer makes a purchase and A_c is reset to 0 until the next advertisement cycle.

After the purchase, the customer evaluates the product by determining the differential between their experiential value and advertised value $\beta - P(\tau)$. If the differential is positive, the customer is satisfied, and trust $T(\tau)$ is nudged up, and vice versa. However, trust can be sticky (Weilbacher, 2003), implying that previous experiences with the product are considered by the customers. To implement this, the model draws on an arithmetic average of the customers' n previous evaluations of the product, which is fed into a sigmoid function $\sigma(z)$. The sigmoid function, in turn, produces the value used to nudge trust. This is in line with recent empirical results drawing from around 300,000 respondents across 71 countries which suggests that product reliability "has become a primary driver of consumer trust in recent years" (Khamitov et al., 2024). The use of the sigmoid function, on the other hand, allows us to bound the delta of trust after every purchase cycle τ which again reflects empirical results which suggest that trust is earned and broken with every customer experience and only in rare situations results in catastrophic loss or dramatic gain in trust. (Khamitov et al., 2024)

Next, the advertiser adjusts their proposed product value $P(\tau)$, based on the number of advertisements they've been running to trigger a sale. To adjust their proposed value, the advertiser calculates their advertisement expenditure by measuring the difference between the number of advertisements in the τ_n^{th} cycle and τ_{n-1}^{th} cycle. If the number of advertisements has increased, the advertiser will decrease their proposed price at a rate γ. This is done in response to a perceived loss of pricing power as their previous advertising cycle indicated a loss of efficacy. The latent variable driving this effect is a decline in trust in the ads on the part of the customer. After the advertiser's proposed price is updated, the customer resets their expected value to their experiential value weighted by their current degree of trust in the advertiser. This final step mimics a reasonable customer who sets their

expected value to the value they've just experienced post-purchase but who is still impacted by their residual trust in the advertisement. This type of dual factor approach to customer-side pricing is discussed by Sung and Chung who indicate that the price a customer is willing to pay is impacted both by the quality of the product and trust in the product, and that customers are willing to pay a premium for products produced by known/trusted brands (Sung et al., 2023).

4.2 Simulations

Below, we discuss three simulated examples along with their associated dynamics and interpretations. In figures 2-7, the x-axis denotes the purchase cycles τ_n. In figures 2, 4, and 6, the red horizontal line represents the experiential value β, the green curve represents the advertiser's proposed value, and the blue curve represents the customer's trust in the advertisement. In figures 3, 5, and 7, the blue curve represents the customer's trust in the advertisement, and the green curve represents the number of ads run by the advertiser during a given purchase cycle τ.

These simulations highlight the various interacting communicative and cognitive processes that create a repertoire of market behaviors. These processes include the advertiser's systematic production of trust, the advertiser's decision to leverage existing trust by raising prices, and to respond to decreasing ad efficacy by lowering prices. On the customer side, they include a willingness to allocate attentional resources to ads, to raise their expected value as a function of trust, to learn about the experienced value of a product, and to gradually lose trust when disappointed. We emphasize that we explore only a subset of all possible strategies. Market participants act with imperfect information about each other and the qualities of the product and attempt to manage cost and risk, including the financial and cognitive costs and risks of communication. Let's explore three scenarios: Communication Failure, Opportunistic Advertising, and Restrained Advertising.

4.3 Communication Failure

We begin with a scenario where the advertiser loses the trust of the customer, resulting in runaway ad spending and a communication breakdown. To model this, we substitute $A_e(\tau)$ in Algorithm 1 with $\gamma(\frac{dT(\tau)}{d\tau})$. Conceptually, this implies that trust is the driving force behind an advertiser's change in proposed value. When trust has positive momentum, the advertiser is incentivized to abuse that trust and increase the proposed value to increase revenue. Conversely, when trust is in decline, the advertiser seeks to rebuild trust by decreasing their proposed value to more closely align with the customer's expected value. In this scenario, when γ is sufficiently small, trust collapses, and the advertiser is too slow in adjusting their proposed value to regain trust quickly. This result is observed in Figure 2, showing a large lag between trust and the proposed price.

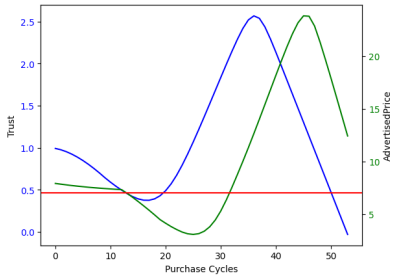

Figure 2: Communication Failure - Green: Advertised Price, Blue: Trust, Red: Initial Advertised Price $A(0)$

This delay results in trust reaching a negative value, where no amount of advertisements can help the advertiser regain trust, as each advertisement will decrease the customer's expected value via the update equation $E(\tau) = E(\tau) + \alpha T(\tau)$. In other words, once trust drops below 0, the customer begins to actively resist attempts by the advertiser to regain their trust. This can be seen in figure 3, where trust precipitates rapidly after the 40th purchase cycle and the advertiser fruitlessly increases the number of ads they run. This situation represents a communication failure between the advertiser and the customer, a term that Ries and Trout use to characterize the state of advertising in the 1970s and 80s (Trout and Ries, 1986).

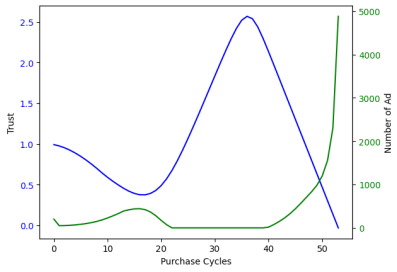

Figure 3: Communication Failure - Green: Number of Ads, Blue: Trust

4.4 Opportunistic Advertising

In this simulation, we revert to our main algorithm and choose a γ that produces stable oscillations. The results are visible in Figure 4, where both the trust and the advertiser's proposed value oscillate fairly regu-

larly. These stable oscillations model the push-and-pull relationship between the advertiser and customer, where pricing power is modulated by trust. Note the slight lag between trust and the advertiser's proposed value: this captures the causal arrow of increasing trust resulting in more efficient advertising and the generation of pricing power. Conversely, when the advertiser notices a drop in trust reflected in decreased sales and low efficacy of their ads, this induces the advertiser to lower their prices to maintain sales and eventually to rebuild trust.

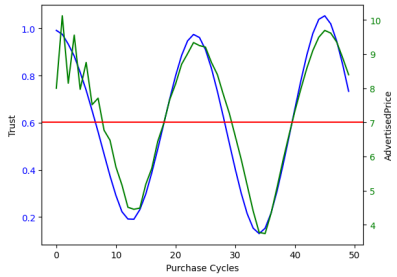

Figure 4: Opportunistic Advertising - Green: Advertised Price, Blue: Trust, Red: Initial Advertised Price $A(0)$

In Figure 5, we find the corresponding advertisement count at each purchasing cycle plotted with the customers' trust. Here, an interesting dynamic emerges between $A_c(\tau)$ and $T(\tau)$. The peaks of trust correspond to the troughs of advertisement and vice versa.

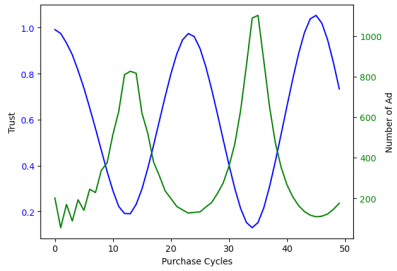

Figure 5: Opportunistic Advertising - Green: Number of Ads, Blue: Trust

This dynamic illustrates that when trust is high, the need for continuous advertisements is reduced since the customer already trusts the product due to repeated positive purchase experiences. Furthermore, when trust is high, the cognitive cost of accepting the advertiser's proposed price is decreased, as the customer has no reason to doubt or scrutinize the advertisement message. This means that each advertisement carries more weight, and, in aggregate, the total number of advertisements required to trigger a purchase is small. However, as customers experience that the product value is no longer as high as they were led to expect by the advertisements, their trust begins to decline and the efficacy of each ad rapidly begins to drop. The advertiser responds at first by increasing the frequency of ads in an attempt to maintain sales, peaking only when the payoff per ad drops too low and the game is no longer worth the candle: customers have lost almost all trust and are no longer responding much to the ads. At that point, the advertiser has lost his ability to maintain high prices and responds by moderating the value claims he makes in the ads. As customers begin to repeatedly find that the advertiser's claims are exceeded by experience, trust finally turns around. The advertiser notices that the efficacy of the ads is rising and responds by decreasing the ad frequency and raising prices, starting a new cycle.

In this scenario, we assume that the manufacturer has a fixed production capacity and is acting to maintain steady sales. A company with a growth capacity may behave differently, for instance by sustaining the frequency of advertising even in a high-trust and high-efficacy environment. This would change the shape of the ad frequency curve; however, it would not change the fundamental dynamics. A company eager to exploit the opportunity for growth would eventually encounter diminishing returns from their advertising campaigns due to falling trust and be forced to moderate their claims and lower their prices to maintain sales.

Do these swings make sense as attempts to secure a larger share of the available value residual? The oscillations pivot around the customers' expected value as determined through their experiences so that the end result is that the surplus value in play is evenly distributed around this axis. Any advantage of advertisers over customers is short-lived and negated in the next downturn; nevertheless, the short-term opportunities are real. Even if it is pointless to swing back and forth, the temptation to try to sell a product for more than it is worth is enduring.

Early advertising was dominated by medical preparations, promising miraculous cures (Gorlach, 2002). "Advertisements are now so numerous that they are very negligently perused," Samuel Johnson wrote in 1759, "and it is therefore become necessary to gain attention by magnificence of promises, and by eloquence sometimes sublime and sometimes pathetic" (Johnson, 1759). Such magnificent promises may work for a while, preying on the naive; how long the favorable wave of exploitation will last is not known in advance and one has the option of going out of business when the bluff is called.

This simple opportunistic advertising cycle is open to refinement, for instance by allowing trust to

be imported from the outside, such as with paid consumer testimonies or expert endorsements.

4.5 Restrained Advertising

By lowering γ, we can moderate the oscillations, signifying that advertisers are less responsive to the temptation to ramp up their claims when ad efficacy is high. Advertisers may learn that staying closer to the facts will progressively narrow the swings in ad efficacy. The outcome is visible in Figure 6, where the advertised price behaves like a dampened oscillator, converging towards the red line of expected value as $\tau \to \infty$.

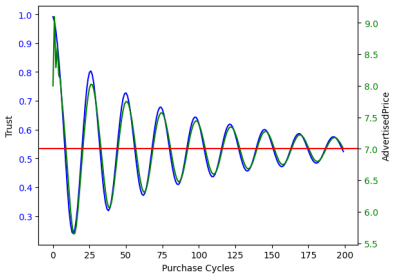

Figure 6: Restrained Advertising - Green: Advertised Price, Blue: Trust, Red: Initial Advertised Price $A(0)$

What the scenario shows is that an enterprise can establish a stable relation with its customers by providing a satisfactory product and advertising it at a value point that matches its experienced value. An advertiser adopting this strategy is showing a restraint that holds it back from exploiting the trust it painstakingly builds. This implies renouncing an opportunity for profit, possibly quite significant. A company wishing to stay in business over the long term, however, may well elect this strategy and prioritize long-term predictability and sustainability over short-term profit.

In Figure 7, the corresponding number of advertisements run during each purchase cycle is plotted, revealing that it similarly approaches a stable value. This means the company's advertising efforts and expenses will stabilize, reducing uncertainty and risk. By communicating effectively and honestly, the company can generate a reliable and sustainable business grounded in satisfied customers.

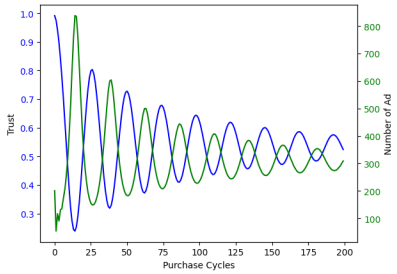

Figure 7: Restrained Advertising - Green: Number of Ads, Blue: Trust

An interesting entailment of the model is that raising the experienced value of the product may be the only stable way in which a company can secure a lasting larger share of the surplus value. This opens up an exploration of whether advertisements in principle are capable of altering not only the expected value of a good but also the experienced value.

The luxury market may be a good domain to study this issue. The experienced value of a product is not simply a fact of the market; it is a complex, multi-dimensional act of cognition. The experience of a product may be modulated by a sustained advertising campaign to establish an exclusive brand. By legally protecting a brand, the advertiser is able to control the associations to the product that the consumer is exposed to, thus constructing a cognitive frame within which the consumer will experience the product (Ogilvy, 1985). In this scenario, the purpose of advertising is to construct a cognitive platform that will raise the customers' assessment of the value of the product experience itself.

5 Conclusion

This paper has explored the dynamics of trust and communication in the context of advertising and market exchanges. We have developed a conceptual, mathematical, and computational model that captures some of the cognitive processes underlying these dynamics, focusing on the role of the cognitive and financial costs of production and reception of ads, the generation and opportunistic leveraging of trust, and the effects of strategic price adaptation.

Our model illustrates how trust is a pivotal element in the customer-advertiser relationship. Trust is built when advertisements accurately communicate product qualities, leading to fulfilled customer expectations. However, this trust is fragile and can be easily eroded if advertisers choose to exploit it by exaggerating product benefits, leading to customer disappointment. In addition, the model shows that the

cognitive cost of processing information from advertisements influences consumer behavior. Consumers are selective in their attention due to these costs and may choose to incrementally ignore advertisements as trust is eroded.

More generally, we propose that the behaviors of producers, advertisers, and customers take place in a space of asymmetrical perceptions of value that in itself does not determine economic outcomes. Instead, a rich panoply of cognitive processes that interact in complex ways allocate the prospective surplus value in ways that often do not reach a stable equilibrium. The emerging patterns may for instance oscillate stably for long periods, certain interventions will progressively dampen these oscillations and result in locally stable states, or trust may plunge below zero and result in communicative failure.

The information-processing approach to market exchanges defines a rich field of research in cognitive microeconomics and a space for computational models to create simulation frameworks for exploring this field. Future research may for instance examine the effects of importing trust into advertising by various means, compare the dynamics of broadcast advertising versus targeted digital advertising, and model how customers' experiences with a product, which in the present model we assume to be invariant, can in fact be nudged up through the cultivation of a brand image – a prospect that has potentially dramatic consequences for the long-term allocation of surplus value.

By situating microeconomics inside cognitive science, we assert that the processes that characterize market exchanges do not follow invariant laws, but instead create unstable possibilities with probabilistic outcomes. Within the context of the model developed above cognitive variables like $\{\beta, \alpha, \gamma, n\}$ form a space of parameters that define an infinite number of possible customer-advertiser dynamics. These parameters can be adjusted stochastically by relevant actors which presents them with a large possibility space of options at each decision point in the market exchange cycle. Only a subset of this space has been explored to date in actual market interactions and only a small subset of the parameter space has been explored in this paper, suggesting that we should expect the continued emergence of new behaviors. A much smaller proportion of behaviors has been modeled in terms of the cognitive processes involved, creating a rich territory for new discoveries.

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