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Discount vouchers and perceived value: Consumer expectation, delight, and disappointment in a formal model

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Abstract: We present a formal mathematical model describing how information about the price of a good might influence the utility a consumer might experience – a novel claim from the view of standard microeconomics, but one that marketing researchers have proposed, at least since Lichtenstein et al (1988).

Our model takes a standard Cobb-Douglas utility function and modifies it based on recent accounts by Schmidt et al (2017) of the so-called Brain Valuation System: a pathway that takes signals about price through the ventromedial prefrontal cortex, there transformed into expectations about quality and satisfaction, then to the anterior prefrontal cortex, which integrates these expectations with the actual experience of consuming a good.

Our model formalises Schmidt et al's experimental results featuring the experience of participants consuming identical servings of wine that are either labelled as cheaper than usual (€3) or more expensive than usual (€18). In particular it shows how, for individuals who are extra-sensitive to price information, goods that are priced unusually high may become disproportionately preferred (say, because of associations with quality). It also shows how under certain conditions, goods that are priced unusually low ("too good to be true") may actually end up being preferred less, perhaps because of suspicions about their quality.

Key Words: consumer behaviour; consumer valuation; neuroeconomics

1. INTRODUCTION

Standard microeconomics has a very simple, powerful theory of consumer behaviour, one that explains how a consumer might figure out the combination of goods that will yield maximum satisfaction. All it requires is information about the consumer's budget and preferences. The budget is usually an amount of money fit against the prices of available goods, and the model for preferences U=f(X,Y) captures how utility depends on the quantity of goods X and Y consumed.

Over the last 40 years, this basic model has been augmented and modified by various insights from psychology, the behavioural, and more lately the neurosciences. In this paper, we focus on one: the possible impact that information about prices might have on consumer satisfaction.

Marketing researchers such as Lichtenstein et al have suggested since the late 1980s that prices, although not directly encoded into the standard model of utility, might actually influence consumer satisfaction. This may be because for some

consumers, prices carry information about quality. It could be that consumers associate better quality with higher prices, or that they prepare themselves for the worst when they purchase goods that are cheaper – say when goods are discounted or sold via vouchers.

To our knowledge, the first major research breakthrough providing not just experimental evidence of the phenomenon but also a neurological mechanism to explain it, arrived very recently, via Schmidt et al (2017) in Scientific Reports (Nature).

The core of the experiment is thus: participants are made to consume identical servings of wine, but one set is priced as three euros and the other as 18 euros. And instead of asking participants to rate or disclose their satisfaction with the wine, functional magnetic resonance imaging is used to track their brain activity and record their real-time consumption experience.

The (simplified) result? Those who consumed the expensive wine registered a bit more enjoyment than usual, but those who thought they were drinking cheap wine definitely enjoyed it less. According to Schmidt et al, this is why: our brains operate a valuation system that involves our ventromedial prefrontal cortex and our anterior prefrontal cortex. When we receive information about prices, the ventromedial prefrontal cortex forms expectations about what we should be experiencing and this signal is combined in the anterior prefrontal cortex with our actual experience consuming the good.

Our contribution in this paper is to incorporate this experimental result and new description of the brain's architecture into a standard utility function to formalise the insight and to see if additional interesting propositions may be derived from it.

2. METHODOLOGY

First we simplify the Brain Valuation System (BVS), the neurological pathway described by Schmidt et al: once information about the price of a good is perceived, it activates the ventromedial prefrontal cortex. This part of the brain uses previous experience or prior knowledge to generate a "reference price", a kind of baseline price to be compared with the newly observed price. In the experiment, the reference price is assumed to be six euros, so for half the participants, the observed price was 18 euros, three times higher than the reference price. For the other participants, the observed price was three euros, half the reference price.

Comparing the observed price with the reference price creates expectations about the coming consumer experience. When the price is high, one presumably expects a better experience, and when it is low, the consumer adjusts accordingly.

All this information is then sent to another part of the brain, the anterior prefrontal cortex. When this area is activated it integrates the consumer's expectations with the actual experience tasting the wine.

Next, we attempt a mathematical translation. We can begin with the standard utility function, in Cobb-Douglas form: $U=X^{a}Y^{1-a}$. The exponents take this relationship from the assumption that the consumer spends a fixed proportion of her income on X and the remainder on Y; this is what her preferences would look like if she did.

Our approach to incorporating the Brain Valuation Mechanism will, at least in this preliminary version of the work, violate the special Cobb-Douglas form. It take the form of the expression $\propto(Po/Pr)$ added to the exponent ^{a} of good X. That is:

$$U=X^{a+\propto(Po/Pr)}Y^{1-a} \qquad \text{(Eq. 1)}$$

Intuitively, this presents the Brain Valuation System as an endogenous determinant of preferences that operates in addition to the standard model which, it must be emphasised, sets preferences exogenously. The ratio Po/Pr compares the observed price Po to the reference price Pr. The coefficient $\propto$ accounts for the various levels of sensitivity a consumer may have toward price information. Some individuals may simply not care about price information, while others may be extra sensitive to it. In Schmidt et al, this sensitivity is linked to a person's sensitivity to monetary rewards in other domains of behaviour.

We then use Mathematica to generate graphs for three base simulations: the canonical version $U=X^{0.5}Y^{0.5}$ (BVS=0), the BVS-augmented version for consumers who drank €18 wine against a reference price of €6, and finally an extreme stylised version for consumers who receive an exceptionally deep discount for a good, say €10 against a reference price of €1,000 (using the €3/€6 wine prices from Schmidt et al's experiment would only weakly show the interesting insight we discovered).

3. RESULTS AND DISCUSSION

Fig. 1 below shows the canonical convex indifference curves found in every microeconomics textbook:

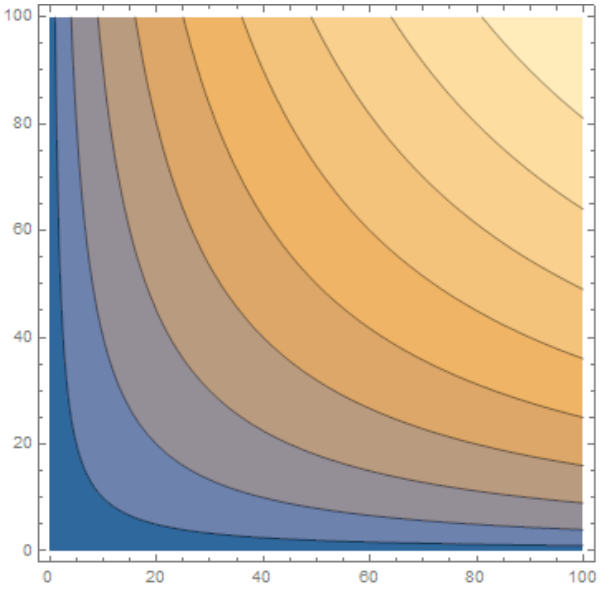

Fig. 1. Graph of $U=X^{0.5}Y^{0.5}$, no BVS

Fig. 2 below graphs the indifference curve of the extra-sensitive consumer given expensive wine:

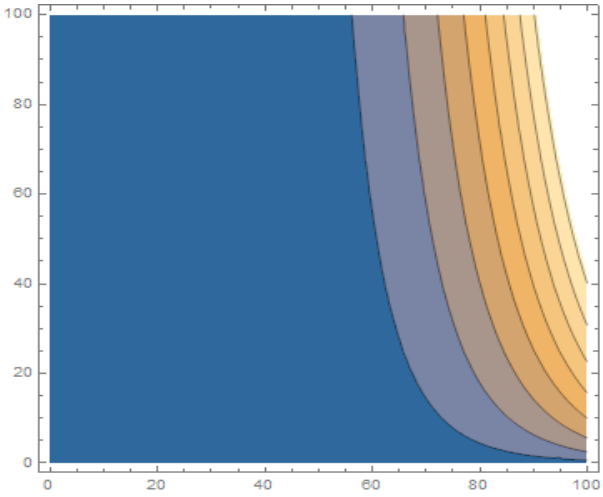

Fig. 2. Graph of $U=X^{0.5+1.3(18/6)}Y^{0.5}$

The key implication from Fig. 2's steepened indifference curve is that as the distance between the observed price and the reference price grows, so presumably does the signal of the good's quality. The result is that X will be preferred much more than before, relative to Y. For any given budget line, the resulting equilibrium will inevitably be found to the right along the X axis, implying a larger than normal purchase of good X.

Fig. 3 on the other hand, shows the indifference curve for consumers who receive a discount seemingly too good to be true (Po/Pr=10/1,000):

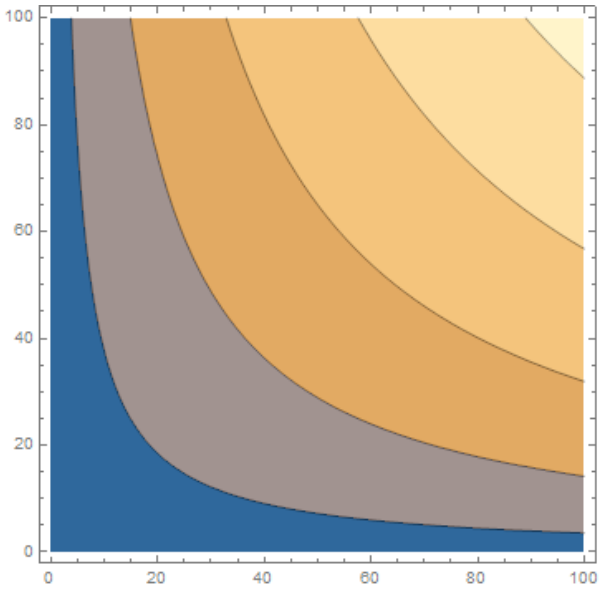

Fig 3. Graph of $U=X^{0.5+1.3(10/1000)}Y^{0.5}$

We use this stylised extreme example because when graphed, the experimental values €3/€6 yield an indifference curve only slightly flatter than Fig. 2, merely indicating that an undervaluation of about 50% will predictably result in consumers wishing to purchase more of good X.

However, an unusually deep discount – say a "too good to be true" Po/Pr ratio of €10/€1,000 – reveals an interesting result long intuited by marketing researchers: consumers who associate prices with quality may grow suspicious, and this is reflected in a much flatter indifference curve; larger disparities between the observed price and the reference price will flatten the curves even further. The extreme flatness has the effect of compressing

available equilibria further toward the northwest portion of the graph, suggesting that despite prices of X being lowered, the consumer will – anomalously, according to micro theory – resist purchasing more X.

4. CONCLUSIONS

To contribute to a theory of how information about prices might alter the experience of satisfaction for a consumer, we formalised the experimental results and neurological mechanism recently described by Schmidt et al. Our formulation is compatible with the standard model of utility, endogenises the formation of preferences and incorporates price information directly into them. It also specifies the conditions under which anomalous behaviour previously described by marketing researchers can emerge from extreme values within the model.

5. REFERENCES

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