Essays on Prosocial Price Premiums

by

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ABSTRACT

In two independent and thematically connected chapters, I investigate consumers'
willingness to pay a price premium in response to product development that entails
prosocial attributes (PATs), those that allude to the reduction of negative externalities
to benefit society, and to an innovative participatory pricing design called 'Pay-What-
You-Want' (PWYW) pricing, a mechanism that relinquishes the determination of
payments in exchange for private goods to the consumers themselves partly relying
on their prosocial preferences to drive positive payments. First, I propose a novel
statistical approach built on the choice based contingent valuation technique to
estimate incremental willingness to pay (IWTP) for PATs that accounts for consumer
heterogeneity, dependence in the decision making processes, and incentive compatibility.
I validate the approach by estimating IWTP for a variety of PATs and contrast the
theoretical and managerial benefits of using the proposed approach over extant
techniques used in the literature for this purpose. Second, I propose a general and
flexible statistical modeling framework for estimating PWYW payments that exceed
zero. It relies on the joint estimation of three types of consumer decision processes
namely, the consumer propensity to default to an explicit price recommendation, the
propensity to pay a least legitimate price, and the payment of a freely-chosen non-zero
payment. Of particular interest is the model's ability to account for a wide variety of
design constraints such as the setting of price bounds, explicit price recommendations,
and the provision of a menu of discrete prices to choose from. I validate the approach
by estimating PWYW payments for a variety of products such as music licenses,
snacks, and sports tickets. I specifically examine and report the differential impact of
three managerially controllable variables namely, 'payment anonymity', 'information
on payment recipients' and 'information of product value/quality'.

DEDICATION

To my mother

D. Florence Beulah

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Chapter 1

PREAMBLE

This dissertation comprises two self-contained essays on the topic of 'Prosocial Price Premiums' each presented as separate chapters. In the first essay, I investigate the consumer response to new product development involving product attributes that allude to reduction of negative externalities to benefit society. Although, this subject has been widely studied in both marketing and economics, the estimation of the incremental consumer willingness to pay (IWTP) for such product attributes suffers from heretofore unaddressed methodological challenges. I present a novel approach to estimating consumer IWTP and use several illustrative empirical examples to demonstrate the usefulness of the method to address issues relevant to both marketing academics and practitioners. In the second essay, I investigate consumer response to Pay-What-You-Want (PWYW) pricing, a mechanism where consumers are given the option to make a payment of their choice in exchange for a private good. The recent increase in the use of this innovative pricing mechanism especially in the exchange of digital goods has prompted a nascent marketing literature that has predominantly focused on the consumer motivations to make a non-zero payment and the drivers of success for firms. I present a novel approach to estimating payments over the least legitimate price that accounts for a wide variety of pricing designs constraints such as price bounds, price recommendations, and menus of discrete price options. The following paragraphs briefly summarize the key commonalities that connect the two essays and the unique contributions of each to the marketing literature.

The essays are connected both thematically and methodologically. The common

theme is the consumers' tendency to take into consideration others' welfare in addition to purely self-interested motives whether it be a decision to pay a premium for a product attribute or a decision to make a positive payment in a PWYW pricing mechanism. The latter can also be considered as a premium over the least legitimate price allowed in a specific PWYW design. As a result, the essays borrow from the literature on prosocial preferences widely examined in both behavioral economics and psychology. Methodologically, the consumer decision to pay premiums are assumed to be fundamentally heterogeneous. Therefore, the methods presented in this work assume the presence of customer segments that respond differentially to similar managerial interventions. I draw from both the statistics and empirical economics literature to develop custom-designed tools for empirical analysis. Additionally, in both essays, I use recent advances in the use of copula functions, joint distributions that allow for dissimilar marginals, in developing multivariate models that examine consumer responses to new products and pricing designs.

In the first essay, I show that despite popular support for sustainable products from consumer groups and government agencies, consumer valuation of a prosocial product attributes (PATs) entails an ambivalent response. In addition to the positive and indifferent valuations, a significant proportion of consumers negatively values PATs owing to subjective perceptions such as 'firm-side cost savings' and 'quality concerns' despite being positively disposed to the prosocial benefits of PAT. I propose a simple empirical approach by eliciting not more than five choice questions in a survey format and use a flexible copula modeling framework to jointly estimate consumers' positive, negative, and zero valuations. I validate the framework by estimating price premiums for PATs for three different products and demonstrate the importance of distinguishing between the underlying factors that influence the heterogeneous valuation of PATs.

In the second essay, I show that three managerially controllable variables, namely 'payment anonymity', 'information on payment recipients', and 'product value' respectively elicit a heterogeneous consumer response. Specifically, I examine three types of responses, the decision to default to a price reference/recommendation, the decision to pay the least legitimate payment, and the magnitude of a freely-chosen non-zero payment. I propose a simple yet flexible statistical model that accounts for design variations in PWYW set-up in addition to dealing with different consumer segments. I validate the model using real PWYW payments for music licenses from an online record label and then use the special cases of the model to analyze two events and two controlled experiments all involving real payments. I show that the consumers' propensity to default to a recommendation price increases when anonymity is lost but the net effect of payment is contingent on the magnitude of the price recommendation. Information on payment recipients influences payments even when they are not explicitly associated with charitable causes. Also, as those that decide to pay a freely-chosen price tend to rely more on subjective valuation, product differentiation and timing of payment are vital in designing a PWYW pricing mechanism.

Chapter 2

CONSUMER RESPONSE TO PROSOCIAL PRODUCT ATTRIBUTES

2.1   Introduction

An ever increasing number of new products contain product attributes that are designed
to enhance societal welfare. For example, consider products that are made with recycled
materials, remanufactured components, or sustainable production processes. These
products often have an attribute that reduces negative externalities such as pollution,
unfair labor treatment, etc. I call such an attribute, a prosocial attribute (PAT)[1].
For instance, computer hardware manufacturers such as Lenovo now report upto
40% recycled material in some of their products[2] and almost every major footwear
brand has products that contain materials recovered from used products[3]. Typically,
firms incur additional costs to include a PAT in products and as a result, managerial
decisions to market such products rely both on consumer demand for such products
and on the estimates of the consumers' incremental willingness-to-pay (IWTP).

For ease of exposition, I refer to the new product with a PAT as simply the 'new
product' and the product without the PAT as the 'base product'. The proportion of the
market that will prefer to buy the new product over the base product (ceteris paribus)
and the distribution of price premiums for a PAT have been the subject of many

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[1]Other equivalent adjectives have been used in the literature for such attributes, such as 'socially
responsible', 'sustainable', etc. and they are interchangeable.

[2]http://www.lenovo.com/social_responsibility/us/en/materials.html.

[3]http://www.wired.com/2012/04/nb-newsky/.

Table 1: Consumer Valuation - Stated WTP Results

Consumer Groups	Recycled Material	Remanufactured	Total
Participants	67	60	127
Buyers at Base Product Price[1]	56 (83.58%)	41 (68.33%)	97 (76.38%)
Non-Zero Premium Payers	46 (68.66%)	30 (50.00%)	76 (59.38%)
Zero Premiums	10 (14.92%)	11 (18.33%)	21 (16.53%)
Non-Buyers at Base Product Price[2]	11 (16.42%)	19 (31.67%)	30 (23.62%)

[1] the participants' stated WTP for base product

[2] potential discount buyers

empirical papers in recent literature (See Tully and Winer (2014) for a recent meta-analysis). Most researchers have used either a conjoint based survey or a contingent valuation survey to arrive at their estimates. However, as PATs are non-central to product functionality, the IWTP distributions are typically characterized by a large number of zeros signifying an indifferent segment of consumers. Additionally, in the case of PATs that require change in product composition (as in the case of recycling, for instance), a significant segment might negatively value the new product. These negative valuations can be driven by reasons unrelated to the prosocial benefits that a PAT alludes to. For example, consumers can perceive new products with PAT to be of lower quality or that the firms marketing the products end up saving production costs through the provision of PAT. These negative valuations driven by subjective perceptions can persist despite firm efforts to explicitly state the impact of having a PAT in a new product. Discarding them altogether or combining them with the indifferent consumers can result in biased estimates of price premiums. As a result, I argue that an estimation of IWTP for PATs should be capable of untangling and jointly estimating the positive, negative, and zero valuations to aid product promotions targeted at increasing the proportion of premium payers.

To illustrate, consider the results of a simple stated willingness-to-pay survey

based on two versions of a laptop computer, one with a PAT (new product) and the other without a PAT (base product). I chose 'post consumer recycling' (raw materials sourced from previously used products) and 'remanufactured components'[4] as the PATs. Participants were recruited from Amazon mTurk and asked to fill out a survey in return for a monetary compensation. The participants first read a detailed description of the base product and then stated their maximum willingness-to-pay (WTP) for it. If their stated WTP was greater than zero, they read a detailed description of the new product (i.e. the one with the PAT) along with an assurance that the new product is identical to the base product in every way including functionality and warranty, the only difference being the presence of a PAT that made the product more environmentally friendly. I then asked them if they would consider buying the new product for the price they stated for the base product. Participants who said yes were asked if they would pay a premium for it. I asked the remaining participants the reasons for their refusal to consider buying the new product. Table 1 shows the results of this simple exercise.

It is noteworthy that a sizable number of consumers responded differently to the same product description. While a large percentage (76%) of the total sample was willing to buy the new product at the same price they are willing to pay for the base product, a sizable part of that group was also willing to pay a premium. Interestingly, those who refused to consider the new product for purchase cited a wide variety of reasons such as perceived firm-side cost reduction (i.e., they thought firms were in fact

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[4]Remanufacturing by definition means bringing a used product back to new product standards with the same warranty. To guard against the possibility of confusing 'remanufacturing' with 'refurbishing', I clearly explained the meaning of both terms during the survey and later checked with the participants at the end of the survey to ensure that they clearly understood that remanufactured products were simply more sustainable variants of the same product and not related to refurbished products sold in the secondary market.

saving money by having PATs), quality concerns (i.e., they refused to believe that the products are of the same quality despite them carrying the same warranty), etc. Three things are immediately apparent from Table 1. First, consumers may not consider new products with a PAT as being equivalent to the base product. Second, consumers who do consider them to be equivalent may still be unwilling to consider a premium, thereby resulting in a zero IWTP. Third, some of those who do not consider the new product as being equivalent to the base product do so due to reasons other than the public benefits offered by the product and may in fact be premium payers if these concerns are addressed i.e. an empirical approach to estimate IWTP for PAT should account for a potential dependence between the processes underlying the decision to consider the new product equivalent to the base product and the magnitude of price premiums paid.

Firm choice of PAT for a new product can be driven by the estimated proportions of the consumers that are either indifferent or negatively disposed to the new product as much as by the magnitude of price premiums of the premium-paying segment. Similarly, an understanding of the drivers of negative valuations can aid in the appropriate design of promotional material that addresses consumer concerns with the PAT. The major contributions of this paper are threefold. First, I introduce a novel and parsimonious survey based IWTP elicitation procedure for PAT that uses a sample of the potential market to answer not more than five dichotomous choice questions. To this end, I build on the Double-Bounded-Dichotomous-Choice (DBDC) approach to estimating WTP that relies on indirectly estimating WTP distributions using consumers' response to dichotomous choice questions pertaining to randomized price bids. Such an approach mitigates biases resulting from strategic responses to socially desirable attributes, is more in line with consumer decision making process,

and is statistically efficient (Hanemann, 1994; Hanemann *et al.*, 1991). Second, I develop a flexible modeling framework to model the consumer responses to the survey. I use the copula approach to jointly estimate the proportion of negative valuations and the magnitude of price premiums for the premium paying population such that a wide variety of non-normal distributional forms for IWTP can be easily accommodated. Third, I demonstrate the usefulness of the approach with empirical examples involving three different products. I contribute to both the emerging literature on consumer response to PATs in new products and the well established literature on the empirical estimation of WTP in marketing.

The rest of the paper is organized as follows. In § 2.2, I introduce the theoretical rationale for the joint estimation of the consumers' negative, positive and zero valuations of PAT and introduce the empirical approach to estimating IWTP with a survey-based elicitation procedure. In § 2.3, I introduce the general modeling framework, its special cases, and its applications. In § 2.4, I present sample empirical applications of the model and discuss their implications. I also show how the procedure can be enhanced by incorporating an adapted BDM auction (Becker *et al.*, 1964) to make it more incentive compatible. Finally, in § 2.5, I conclude with a general discussion of the contributions, possible applications of this approach both in survey based research and in experimental behavioral research, some important limitations and avenues for future research.

2.2 Theory and Empirical Approach

In this section, I briefly discuss the theoretical rationale behind the different types of consumer responses to the presence of a PAT in new products and an empirical approach to estimating IWTP using survey data.

2.2.1 Theoretical Rationale

Some consumers with a positive WTP for the base product do not consider buying a new product with a PAT even though the two products are stated to be similar in every other aspect except the PAT. In order to understand this consumer decision, one needs to start with the understanding of how a 'product attribute' maps onto a 'product benefit' in the mind of the consumer[5]. A 'product attribute' can be defined as an objective and measurable component of a product i.e. it can be quantified in such a way that comparative judgments can be made about the levels of an attribute in competing products. For instance, in the case of a laptop computer, the screen size, processing speed, battery power, price etc. can be referred to as product attributes. In contrast, I define a 'product benefit' as a more subjective aspect of a product. For instance, aspects like quality, comfort, luxury, beauty are more subjective and therefore suitable to describe a product's benefits in more abstract terms. The theoretical rationale for characterizing products in terms of its constituent attributes or benefits can be traced back to Lancaster's 'A New Approach to Consumer Theory' (Lancaster, 1966). In his interpretive essay, Ratchford (1975) provided the link between this theory and some of the product marketing tools used for valuing attributes. A key aspect of any valuation exercise is to present attributes in such a way that consumers are clearly able to map them onto their respective benefits (or detriments) so as to ensure a uniform market perception even though preferences for the respective attributes might be heterogeneous. However, in the case of nominal attributes such as PATs,

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[5]The literature is not entirely consistent with the use of these terms. The word 'attribute' has been used for both objective and subjective product aspects and the word 'characteristic' has been used for describing more abstract product benefits. However, I clarify the definitional distinction between the terms 'product attribute' and 'product benefit' in this section for ease of theoretical exposition.

perceptual differences tend to remain even with the explicit communication of all their consequences.

Negative Valuation of a PAT. As demonstrated in the introductory example, a significant percentage of the market viewed the PAT as detrimental to the product despite being positively disposed towards the public benefit resulting from the attribute. Two important factors influence the subjective judgment of consumers leading to a negative valuation. First, consumers tend to associate the presence of PAT to a reduction in quality. Quality concerns can be related to either the functionality (such as durability) or the 'newness of the product' (such as the presence of materials recovered from previously used products). Second, some consumers associate PAT with a decrease in manufacturing costs affecting their perception of a fair-price for the new product with PAT. The concept of memory based reference prices are known to play a key role in product evaluations (Briesch *et al.*, 1997; Monroe, 1973). In the case of a PAT such as 'recycling', consumers may have been exposed to premium pricing whereas in the case of a PAT such as 'remanufacturing', consumers may have been exposed to discounted prices in some product categories (owing to reasons such as the threat of cannibalization (Atasu *et al.*, 2010)) such as machine tools. Empirical approaches that measure IWTP for a product attribute at the market level can neglect negative valuations if a small percentage of the population values a product negatively. However, attributes like PATs can entail a larger segment necessitating an explicit modeling of the phenomenon. For the explicit modeling of negative valuations along with the positives in the non-market public good valuation literature, see Clinch and Murphy (2001).

Zero Valuation of a PAT. Even if consumers consider a new product with a PAT as being equivalent to the base product in every other respect, they may not pay a

premium for it i.e. they may be indifferent to the presence of a PAT in the product resulting in an IWTP of $0. Consumer indifference may be a genuine indication of lack of utility in PAT. In the absence of a clear product-specific benefit from a PAT, consumers can refrain from considering a price premium (Ginsberg and Bloom, 2004). In contrast, even if consumers are positively disposed to a PAT, factors such as 'attribution of responsibility' or a lack of 'trust' in firms' claims about PATs and its efficacy can lead to zero valuations (Osterhus, 1997). Literature in social psychology has shown that prosocial behavior is related to the extent to which consumers take responsibility for societal harm (Schwartz, 1968). In the case of certain products, consumers might attribute greater responsibility to firms than to themselves resulting in an IWTP of $0 for the PAT. Additionally, zero valuations can be the response to consumer lack of trust driven by the prevalence of deceptive advertising campaigns by firms claiming to be more environmentally friendly than they actually are (generally referred to by the term 'greenwashing').

Price Premiums and Discounts. A recent meta-analysis of the IWTP estimated for products with a PAT indicates that, on average, 60% of the study participants are willing to pay a price premium of roughly 17% of the price of the base product (Tully and Winer, 2014). The exact type of PAT and the individual specific differences in consumer concern for the prosocial benefit being addressed can drive variation in price premiums. However, in many cases, the consumer valuation of the base product can serve as an anchor to determine the premium. In most products, the PAT is either present or absent i.e. a dichotomous attribute[6]. With the levels of an attribute not easily determined, the consumer may use a fraction of the value of the base product as

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[6]Although in the case of the usage of recycled materials in production, it is not uncommon to find manufacturers disclosing percentage values to indicate the level of the attribute such as the description '25% sourced from post consumer recycling'.

an indicator of a fair premium. Post survey interaction with participants during the pretests indicated that many thought about a fair premium in terms of a percentage of the value of the base product. Consequently, different base products with the same description of a PAT can yield different price premiums.

For consumers who refused to consider the new product with PAT as equivalent to the base product, it is also worthwhile to examine the minimum discount at which they would choose a new product over a base product. Knowledge of the minimum discount for consumers with negative valuations can aid in price discrimination especially in cases where the presence of a PAT is beneficial to the firm for benefits such as tax subsidies from the government. However, it is possible that some consumers will not buy the new product at any discount owing to a fundamental dislike for the PAT in the product (I call these consumers the 'Never-Switchers'). It is imperative that this segment of consumers is not included in the estimation of minimum discounts to avoid an overestimation.

2.2.2 An Empirical Approach

As the IWTP measure is relevant only for the consumers who already have a positive WTP for the base product (i.e. only for those who are already in the market for the base product), it can be thought of as a price differential that makes the consumer indifferent between the base product and the new product. Let P_e be the proportion of consumers that consider the new product with PAT as being equivalent (at least) to the base product, implying that $(1 - P_e)$ percent of the consumers negatively value the presence of PAT in the new product. Let P_p be the subset of P_e that are willing to pay a price premium, implying that $(1 - P_p)$ percent of P_e are indifferent to the presence of a PAT. Similarly, among those who negatively valued the product, let P_d

be the proportion of consumers that are willing to buy the new product for a discount, implying that $(1 - P_d)$ percent of $(1 - P_e)$ are not willing to switch to the new product irrespective of the amount of discount i.e., the 'never-switchers'. The IWTP for the PAT may now be written as:

$$
\begin{aligned}
\text{IWTP} = P_e[P_p \times \text{IWTP}^+ + (1 - P_p) \times \text{IWTP}^0] + \\
(1 - P_e)[P_d \times \text{IWTP}^- + (1 - P_d) \times \text{IWTP}^\star],
\end{aligned} \tag{2.1}
$$

where IWTP^+ and IWTP^- represent positive and negative valuations respectively, each following a distribution with non-negative support. IWTP^0 represents indifference i.e. \$0 while $\text{IWTP}^\star$ is unknown and represents the IWTP of a consumer who refuses to buy the new product with PAT at any price. Now the average price premiums $(\overline{P})$ and discounts $(\overline{D})$ as a result of introducing a PAT in a product can be written as:

$$
\begin{aligned}
\overline{P} = P_e \times P_p \times \mathbb{E}[\text{IWTP}^+]; \\
\overline{D} = (1 - P_e) \times P_d \times \mathbb{E}[\text{IWTP}^-].
\end{aligned} \tag{2.2}
$$

I model P_e, P_p, P_d, $\mathbb{E}[\text{IWTP}^+]$, and $\mathbb{E}[\text{IWTP}^-]$ as functions of product and consumer specific factors. The success of a new product with PAT depends on the firm's ability to increase P_e, P_p, and $\mathbb{E}[\text{IWTP}^+]$. Before I formalize a statistical model, I first introduce an IWTP elicitation procedure that captures consumer responses to a base product and its corresponding new product with a PAT.

Figure 1 provides a detailed flowchart of the IWTP elicitation procedure. I begin with the consumer WTP for the base product. I use a stated maximum willingness to pay in the presence of accurate product information including detailed product description, price range, previous consumer review ratings and the market price at the time of survey to identify consumers who are in the market for the base product.

Participants who state non-zero values are considered as market participants and the individual specific WTP for the base product is used to customize the questions in the survey and also to control for the impact of the base product's reservation price that consumers may use as an anchor to decide the incremental value of the PAT [7]. All the participants with non-zero WTP for the base product were provided with a detailed description of the new product with PAT while emphasizing that the new product is functionally equivalent to the base product except for the presence of a PAT. I then ask the participants if they would consider switching to the new product for the same price that they stated for the base product. Those who answer 'No' do not consider the new product as equivalent to the base product. For the participants who answer 'Yes', I use randomly selected price bids B_1, B_H, and B_L such that $B_H > B_1 > B_L$ to locate the maximum premium they are willing to pay. First, I ask if the participant will consider buying the new product for a premium of $\$B_1$. If the answer is 'Yes', I ask if they would consider buying the new product for a premium of $\$B_H$, a higher price point. If the answer is 'No', I ask if they would consider buying the new product for a premium of $\$B_L$, a lower price point. Of particular interest is the participant who answers 'No' to the lower price bid B_L. In order to verify if this is a case of the participant being indifferent to the presence of the PAT I ask the participant if they are 'willing to pay anything extra at all' for the PAT. This procedure makes sure that consumers do not strategically overbid or underbid as is the case when they are asked to specify a dollar value directly.

Among those participants who did not consider the new product as equivalent to

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[7]The stated maximum WTP for the base product may not be an accurate measure of the reservation price of the base product. For a more accurate representation of the base product's reservation price, an incentive compatible BDM auction can replace a stated WTP measure wherever possible, as demonstrated later.
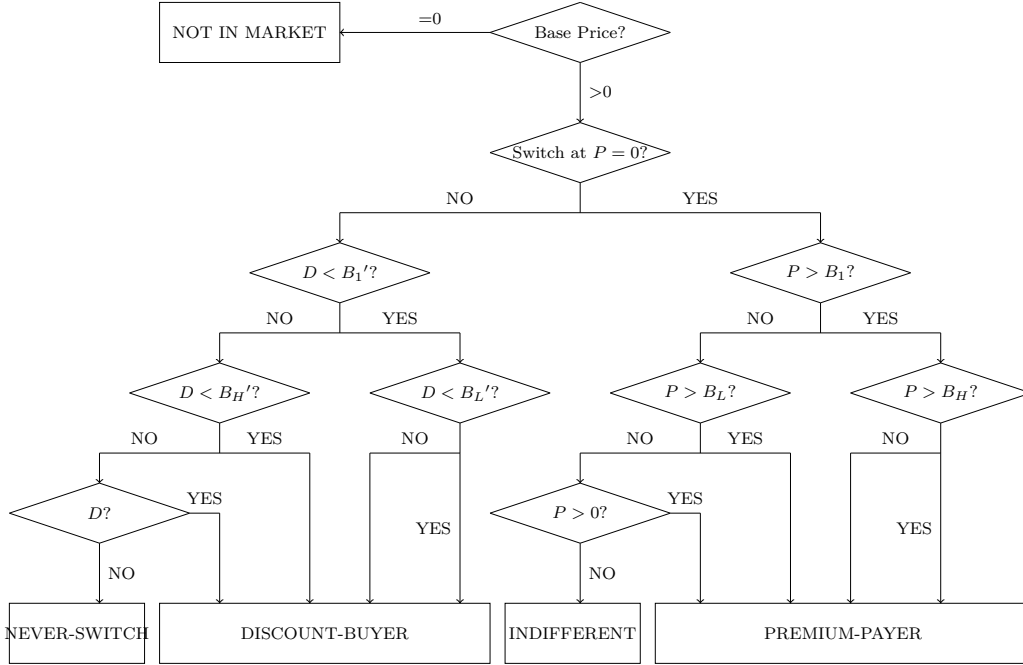
Base Price - Maximum willingness to pay for the base product
P - Maximum premium the consumer is willing to pay for the new attribute
D - Minimum discount for which the consumer will switch to the product with the new attribute
(B_1, B_H, B_L), (B_1', B_H', B_L') - Bids to locate premiums and discounts using dichotomous choice questions
$B_H > B_1 > B_L$; $B_H' > B_1' > B_L'$

Figure 1: Premium and Discount Elicitation

the base product, some participants will be willing to buy the product for a discount while others may refuse to switch at any price point (never-switchers)[8]. Once again, I use random price bids B_1', B_H', and B_L' such that $B_H' > B_1' > B_L'$ and a double bounded dichotomous choice process to locate the minimum discount for which the consumer would consider switching from the base product to the new product. I ask those who answer 'No' to the highest discount offer if they would consider buying the product at any discount to confirm that they are indeed never-switchers.

In order to identify the latent premiums and discounts underlying the consumer

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[8]Never-switchers at any discount can be a significant part of the sample in the case of public causes that some participants might find morally incompatible with their values or religious beliefs.

choices to price bids, it is important to choose bid combinations based on the results of pretesting i.e. price bids should be tested in advance on different samples to verify that the premiums of a significant fraction of the sample indeed lies on each of the four regions $(0, B_L], (B_L, B_1], (B_1, B_H], (B_H, \infty)$. Alternatively, price bids can also be fixed percentage values of the base product's maximum WTP, which provides greater variation in the bid sets as different consumers have different maximum WTP for the base product. This procedure ensures that I ask any participant in the market for a given base product no more than five choice questions irrespective of the group they belong to whether they be premium payers, indifferent, discount buyers, or never-switchers.

In contrast to the other popular approaches to measuring IWTP such as conjoint analysis (Jedidi and Zhang, 2002)[9] and hedonic regression (Rosen, 1974)[10], the proposed elicitation procedure is custom designed to parsimoniously capture the qualitative differences in the consumer valuation process and provide for the joint estimation of the proportion of negative valuations and the magnitude of price premiums to avoid biased estimates of price premiums. However, a key limitation of the direct elicitation approach to measuring IWTP is the problem of 'incentive compatibility' i.e., consumers lacking an incentive to be truthful about the prices they state. In general, incentive compatibility is hard to achieve without a real purchase scenario i.e., the

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[9]Conjoint analysis is a better alternative to approximate IWTP for multiple product attributes at the same time using relative prices as long as the attributes are central to product choice and not susceptible to severe perceptual differences.

[10]It is possible to infer the IWTP of certain PATs through revealed preferences if products with and without a PAT are available at different price points. However, firms do not practice demand-based pricing for PATs in products. In certain product categories, prices for products with remanufactured components are set lower than the base products to avoid product cannibalization. Previous literature has highlighted how manufacturers might be losing profits by discarding consumer surplus in products with PAT (Atasu *et al.*, 2008).

consumer should face the possibility of losing or gaining real value during the valuation exercise. The proposed framework relies on a choice based approach to mitigate the problem of incentive compatibility in the measurement of IWTP for hypothetical attributes (consumers never state their premiums directly but only choose between random price bids). Additionally, whenever a field study is feasible, the proposed elicitation procedure can be enhanced by replacing the stated maximum WTP for the base product with an adapted BDM auction (Becker *et al.*, 1964) even for relatively high value products. This ensures a closer approximation of the reservation price for the base product as I demonstrate in Study 3 of the empirical section. In the next section, I introduce a flexible modeling framework to analyze the outcomes of the proposed IWTP elicitation procedure.

2.3   Statistical Model

I specify two general models to analyze and interpret the discrete outcomes of the proposed IWTP elicitation procedure, one for price premiums and the other for discounts. While the model for estimating the price premium considers the entire sample, the one for discounts works with the selected sub-sample that negatively values the product.

2.3.1   Bivariate Price Premiums with Zero-Inflation

Price premiums are observed only for those consumers who would consider switching to the new product for a price that is equal to their stated maximum WTP for the base product i.e. those who answer 'Yes' to the second question in Figure 1. I specify two latent variables e^* and p^* to model the choice to switch at the price of the base product and the price premiums when they are observed respectively. Price premium

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p^* is observed only when e^* is greater than 0. In the general case, I consider e^* and p^* to be jointly distributed in order to account for any correlation between e^* and p^*. Also, in order to account for spike in zero values (zero inflation) in premiums owing to consumer indifference to the PAT, I assume another latent variable v^* that captures the positive valuation of the PAT such that a price premium p^* is observed only when v^* is greater than 0. Otherwise, the zero value is assumed to be a result of true indifference. The splitting of the data generating process to account for zero inflation is common in count data modeling (Mullahy, 1986). I model the latent variables e^*, v^* and p^* as functions of product and consumer specific characteristics. One can specify the discrete outcomes of the premium elicitation using indicator variables as

$$I_e = \begin{cases} 1, & \text{if } e^* > 0 \quad \text{where } e^* \sim F_e(k_e, \theta_e); \; \mathbb{E}[e^*|\mathbf{X_e}] = g_e(\mathbf{X_e}, \beta_\mathbf{e}) \\ 0, & \text{otherwise} \end{cases}$$
(2.3)

$$I_p = \begin{cases} 0, & \text{if } v^* \leq 0 \quad \text{where } v^* \sim F_v(k_v, \theta_v); \; \mathbb{E}[v^*|\mathbf{X_v}] = g_v(\mathbf{X_v}, \beta_\mathbf{v}) \\ 1, & \text{if } p^* \leq B_L \text{ and } v^* > 0 \quad \text{where } p^* \sim F_p(k_p, \theta_p); \; \mathbb{E}[p^*|\mathbf{X_p}] = g_p(\mathbf{X_p}, \beta_\mathbf{p}) \\ 2, & \text{if } B_L \leq p^* < B_1 \text{ and } v^* > 0 \\ 3, & \text{if } B_1 \leq p^* < B_H \text{ and } v^* > 0 \\ 4, & \text{if } p^* > B_H \text{ and } v^* > 0 \\ \text{unobserved}, & \text{if } e^* \leq 0 \end{cases}$$

$$\text{where } F_{ep}(\rho_{ep}) = \begin{cases} F_e \times F_p, & \text{if } \rho_{ep} = 0 \\ C(F_e, F_p; \rho_{ep}), & \text{otherwise.} \end{cases}$$
(2.4)

I_e and I_p are indicator variables taking discrete values. Note that I_p is observed only when $I_e = 1$ i.e. $e^* > 0$. The expected values of the latent variables are modeled as a function $g(\cdot)$ of product and consumer specific covariates ($\mathbf{X}$) and a vector of

parameters of interest (β). The specific form of the function is dependent on the support of the expected value of the chosen parametric distribution. $F_e, F_p,$ and F_v are the cumulative distribution functions of the latent variables $e^*, p^*,$ and v^* respectively, each with two parameters, a dependent parameter (k_e, k_p, k_v) modeled as a function of the expected value g, and an independent parameter $(\theta_e, \theta_p, \theta_v)$ that is preset to 1 for e^* and v^* and estimated from the data for the latent p^*. For both e^* and v^*, one can use a latent normal or a logistic specification while for price premiums p^*, one can use a non-negative distribution such as a Gamma or Weibull. Table 2 delineates the specific functional forms for g, k, F for various distributions that are commonly used in the empirical literature to model prices. The likelihood of the general model can be written as:

$$\mathcal{L}_p = \prod_{I_e=0} \Pr(e^* \leq 0) \prod_{I_p=0} \Pr(e^* > 0) \Pr(v^* \leq 0) \prod_{I_p \neq 0} \Pr(v^* > 0)$$
$$\times \left[\prod_{I_p=1} \Pr(e^* > 0, p^* \leq B_L) \prod_{I_p=2} \Pr(e^* > 0, B_L < p^* \leq B_1) \right. \tag{2.5}$$
$$\left. \times \prod_{I_p=3} \Pr(e^* > 0, B_1 < p^* \leq B_H) \prod_{I_p=4} \Pr(e^* > 0, p^* > B_H) \right].$$

2.3.2   Estimation: A Copula Approach

In order to accommodate joint estimation of e^* and p^* as correlated variables, one can assume that the premium generating process and the dependent choice process are together bivariate normal (Strazzera *et al.*, 2003; Yoo and Yang, 2001). In contrast, statistical copulas provide a more flexible approach to model dependencies when the dependent random variables belong to different types of distributions (Danaher and Smith, 2011; Genius and Strazzera, 2008; Smith, 2003). I model the dependence

Table 2: Latent Variable Specification

Latent Variable	Type	$g(\mathbf{X}, \beta)^{\star}$	$k(g,\theta)^{\#}$	$\theta^{\dagger}$	$F(k,\theta)^{\ddagger}$
e^*, v^*, s^*	Normal	$\mathbf{X}\beta$	g	1	$\frac{1}{2\pi}\int_{-\infty}^{\frac{x-k}{\theta}} e^{\frac{-t^2}{2}}\,\mathrm{d}t$
	Logistic	$\mathbf{X}\beta$	g	1	$\frac{1}{1+e^{-\frac{x-k}{\theta}}}$
p^*, d^*	Gamma	$e^{\mathbf{X}\beta}$	$\frac{g}{\theta}$	estimated	$\frac{1}{\Gamma(k)}\gamma(k,\frac{x}{\theta})$
	Lognormal	$e^{\mathbf{X}\beta}$	$\ln(g) - \frac{\theta^2}{2}$	estimated	$\frac{1}{2\pi}\int_{-\infty}^{\frac{\ln(x)-k}{\theta}} e^{\frac{-t^2}{2}}\,\mathrm{d}t$
	Loglogistic	$e^{\mathbf{X}\beta}$	$g \times \frac{\theta}{\pi}\sin(\frac{\pi}{\theta})$	estimated	$\frac{1}{1+\left(\frac{x}{k}\right)^{-\theta}}$
	Weibull	$e^{\mathbf{X}\beta}$	$\frac{g}{1+\Gamma(\frac{1}{\theta})}$	estimated	$1 - e^{-\left(\frac{x}{k}\right)^{\theta}}$
	Pareto (Lomax)	$e^{\mathbf{X}\beta}$	$g(\theta - 1)$	estimated	$1 - \left(1 + \frac{x}{k}\right)^{-\theta}$

$\star$ functional form of the expected value $\#$ parameter dependent on covariates
$\dagger$ parameter independent of covariates $\ddagger$ cumulative distribution function of latent variable 'x'
$\gamma(k, \frac{x}{\theta}) = \int_0^{\frac{x}{\theta}} t^{k-1}e^{-t}\mathrm{d}t$

structure between F_e and F_p using a bivariate copula function C that takes F_e, F_p and a dependence parameter ρ_{ep} as its arguments. The theoretical basis is due to Sklar's theorem (Sklar, 1973) that allows one to write a bivariate distribution as a function of its uniform marginals (F_e and F_p) and a dependence parameter (ρ_{ep}). The range of ρ_{ep} depends on the specific functional form of C.

There are generally two considerations for selecting a functional form for C. First, its ability to capture the dependence uniformly along the entire range of the marginal distributions and second, its ability to be robust to any misspecification of the joint distribution [11] (Trivedi and Zimmer, 2007). The Gaussian copula satisfies both the aforementioned range and robustness requirements (Song, 2000; Danaher and Smith, 2011). The joint distribution can be written using a Gaussian copula as $C = \Phi_2(\Phi^{-1}(F_e), \Phi^{-1}(F_p); \rho_{ep})$ where Φ_2 is the bivariate standard normal distribution and ρ_{ep} is the correlation coefficient between e^* and p^*. ρ_{ep} ranges from -1 to $+1$ with

---

[11] Identification of the exact nature of the dependence ρ_{ep} between the unobservables e^* and p^* is an empirical exercise and might as well be different for different products or different PATs. I do not set any a priori expectation.

the zero indicating independence. When $\rho_{ep} = 0$, the copula function can be replaced by the product copula i.e. the product of the marginal univariate distributions.

In order to rewrite Equation 2.5 in terms of the cumulative distribution functions, I use the following identities.

$$\Pr(a < X \leq b, c < Y \leq d) \equiv F_{XY}(b,d) - F_{XY}(a,d) - F_{XY}(b,c) + F_{XY}(a,c).$$

$$F_{XY}(\infty, \infty) \equiv 1.$$

$$F_{XY}(X, \infty) \equiv F_x(X). \tag{2.6}$$

$$F_{XY}(\infty, Y) \equiv F_y(Y).$$

$$F_{XY}(X, -\infty) \equiv F_{XY}(-\infty, Y) = F_{XY}(-\infty, -\infty) = 0.$$

where F_{XY} is a bivariate cumulative distribution function of variables X and Y. With simple algebraic operations, Equation 2.5 simplifies to

$$
\begin{aligned}
\mathcal{L}_p = \prod_{I_e=0} \{F_e(0)\} \prod_{I_p=0} \{F_v(0) - F_e(0)F_v(0)\} \prod_{I_p \neq 0} \{1 - F_v(0)\} \\
\times \Bigg[\prod_{I_p=1} \{F_p(B_L) - F_{ep}(0, B_L)\} \\
\times \prod_{I_p=2} \{F_p(B_1) - F_p(B_L) - F_{ep}(0, B_1) + F_{ep}(0, B_L)\} \\
\times \prod_{I_p=3} \{F_p(B_H) - F_p(B_1) - F_{ep}(0, B_H) + F_{ep}(0, B_1)\} \\
\times \prod_{I_p=4} \{1 - F_p(B_H) - F_e(0) + F_{ep}(0, B_H)\} \Bigg].
\end{aligned}
\tag{2.7}
$$

Whether a consumer considers the new product to be equivalent to the base product is typically modeled using a latent normal (as in a Probit model) or a latent logistic (as in a Logit model). However, the price premiums are non-negative and are typically modeled using a non-normal distribution such as a Gamma or a Weibull distribution. Replacing F_{ep} in Equation 2.7 with a bivariate copula function C yields Equation 2.8. Apart from providing the ability to write the likelihood of a joint distribution with

dissimilar marginals, the use of a copula greatly simplifies the estimation of the model. Copula models allows for the disentangling of the dependence parameter from the marginals such that the dependence parameter can be estimated independent of the estimation of parameters of the marginal distribution. I delineate the procedure in APPENDIX A and show that the estimator is well-behaved for different distributional assumptions using Monte-Carlo simulations.

$$\mathcal{L}_p = \prod_{I_e=0} \{F_e(0)\} \prod_{I_p=0} \{F_v(0) - F_e(0)F_v(0)\} \prod_{I_p \neq 0} \{1 - F_v(0)\}$$

$$\times \left[\prod_{I_p=1} \{F_p(B_L) - C(F_e(0), F_p(B_L); \rho_{ep})\} \right.$$

$$\times \prod_{I_p=2} \{F_p(B_1) - F_p(B_L) - C(F_e(0), F_p(B_1); \rho_{ep}) + C(F_e(0), F_p(B_L); \rho_{ep})\} \quad (2.8)$$

$$\times \prod_{I_p=3} \{F_p(B_H) - F_p(B_1) - C(F_e(0), F_p(B_H); \rho_{ep}) + C(F_e(0), F_p(B_1); \rho_{ep})\}$$

$$\left. \times \prod_{I_p=4} \{1 - F_p(B_H) - F_e(0) + C(F_e(0), F_p(B_H); \rho_{ep})\} \right]$$

A few special cases of the model can be derived by employing additional assumptions. I describe the usefulness of three such models and their likelihood functions here. First, if the population is strictly split into two groups: those that negatively value the PAT and those that are indifferent at the least, the assumption of conditional independence of e^* and p^* yields a special case of the model that does not rely on any copula function. Models of this flavor have been previously used in the marketing literature (Chandrashekaran and Sinha, 1995; Sinha and Chandrashekaran, 1992). In such a case, the premiums are simply assumed to be zero values when $e^* < 0$ instead of their being counted as unobserved as in Equation 2.4. Setting $\rho_{ep} = 0$ in Equation 2.8, the likelihood for such a model is given by

$$\mathcal{L}_p = \prod_{I_e=0} \{F_e(0)\} \prod_{I_p=0} \{F_v(0) - F_e(0)F_v(0)\} \prod_{I_p \neq 0} \{1 - F_v(0)\}$$

$$\times \Bigg[\prod_{I_p=1} \{F_p(B_L) - F_e(0)F_p(B_L)\}$$

$$\times \prod_{I_p=2} \{F_p(B_1) - F_p(B_L) - F_e(0)F_p(B_1) + F_e(0)F_p(B_L)\} \qquad (2.9)$$

$$\times \prod_{I_p=3} \{F_p(B_H) - F_p(B_1) - F_e(0)F_p(B_H) + F_e(0)F_p(B_1)\}$$

$$\times \prod_{I_p=4} \{1 - F_p(B_H) - F_e(0) + F_e(0)F_p(B_H)\} \Bigg].$$

Second, for some PATs, it may not be straightforward to distinguish between the indifferent zeros and positive valuation zeros (or near zero values). For instance, those that answer affirmatively to the question 'Will you pay a premium at all?' may form the overwhelming majority of the survey resulting in a mode that lies in the region $(0, B_L]$. One can discard the latent variable v^* in such a scenario and instead estimate a unimodal distribution (without any zero inflation) of price premiums. The premiums are still assumed to be unobserved when $e^* \leq 0$. This model is fit for a market that is split into two groups, those who positively value the sustainable product and those who have reservations accepting the product for the same price as the base product. Setting $F_v(0) = 0$ in Equation 2.9, the likelihood for such a model is

$$\mathcal{L}_p = \prod_{I_e=0} \{F_e(0)\} \prod_{I_p=1} \{F_p(B_L) - C(F_e(0), F_p(B_L); \rho_{ep})\}$$

$$\times \prod_{I_p=2} \{F_p(B_1) - F_p(B_L) - C(F_e(0), F_p(B_1); \rho_{ep}) + C(F_e(0), F_p(B_L); \rho_{ep})\}$$

$$\qquad (2.10)$$

$$\times \prod_{I_p=3} \{F_p(B_H) - F_p(B_1) - C(F_e(0), F_p(B_H); \rho_{ep}) + C(F_e(0), F_p(B_1); \rho_{ep})\}$$

$$\times \prod_{I_p=4} \{1 - F_p(B_H) - F_e(0) + C(F_e(0), F_p(B_H); \rho_{ep})\}.$$

Third, for some products, the fraction of those who negatively value the product

can be negligible or non-existent i.e. most of the population considers the product with the PAT equivalent to the base product (as is the case with many cause related marketing campaigns where promotion of public causes are tied to products). If the PAT does not alter the product's composition, a special case of that model that discards the latent variable e^* might be more applicable. Note that such a model will still distinguish between positive valuation and indifference. Models of this type have been used in the marketing literature pertaining to valuation of digital music in the presence of pirates who will never pay (Sinha *et al.*, 2010). Setting $F_e(0) = 0$ in Equation 2.10, the likelihood for such a model is

$$
\mathcal{L}_p = \prod_{I_p=0} \{F_v(0)\} \prod_{I_p \neq 0} \{1 - F_v(0)\}
$$
$$
\times \left[\prod_{I_p=1} \{F_p(B_L)\} \prod_{I_p=2} \{F_p(B_1) - F_p(B_L)\} \prod_{I_p=3} \{F_p(B_H) - F_p(B_1)\} \prod_{I_p=4} \{1 - F_p(B_H)\} \right].
$$
(2.11)

Setting both $F_e(0)$ and $F_v(0)$ to 0 results in the basic Double-Bounded-Dichotomous-Choice model (DBDC) that is widely used by environmental economists to estimate the demand for public goods. In this case, it simply measures the price premiums as the incremental value of the PAT in the new product.

$$
\mathcal{L}_p = \prod_{I_p=1} \{F_p(B_L)\} \prod_{I_p=2} \{F_p(B_1) - F_p(B_L)\} \prod_{I_p=3} \{F_p(B_H) - F_p(B_1)\} \prod_{I_p=4} \{1 - F_p(B_H)\} \quad (2.12)
$$

When normality is assumed for the univariate likelihoood of Equation 2.12, price premiums can be assumed to follow a latent normal distribution such that the negative values correspond to price discounts and non-negative values correspond to price premiums. The likelihood for such a model is given by Equation 2.13. The model does not distinguish between the qualitative differences in zeros and combines premiums and discounts as a latent measure of consumer valuation in $(-\infty, \infty)$. This model

can serve as a useful baseline in model selection as it estimates the least number of parameters while still accounting for values less than zero.

$$\mathcal{L}_p = \prod_{p^*<0} \{\mathcal{N}(0,\sigma)\} \prod_{I_p=1} \{\mathcal{N}(B_L,\sigma) - \mathcal{N}(0,\sigma)\}$$
$$\times \prod_{I_p=2} \{\mathcal{N}(B_1,\sigma) - \mathcal{N}(B_L,\sigma)\} \prod_{I_p=3} \{\mathcal{N}(B_H,\sigma) - \mathcal{N}(B_1,\sigma)\} \prod_{I_p=4} \{1 - \mathcal{N}(B_H,\sigma)\}$$

(2.13)

2.3.3 Discount Buyers and Never-Switchers

Consumers who refused to consider buying the new product for the price of base product i.e., those who answered 'No' to the second question in Figure 1, are still faced with the choice of buying the product at a discount. If this fraction is well represented in the sample, one can estimate the minimum discount at which the consumer will buy the product (as a function of consumer and product specific factors). This is useful information for managers wishing to target this segment of consumers and discriminate on the basis of price. Theoretically, discounts serve as a proxy for negative valuation of PATs. An understanding of the factors driving minimum discounts can assist in product modification and promotion decisions.

I specify a latent variable d^* following a non-negative distribution whose dependent parameter is a function of the relevant covariates. The model specification is similar to the set up for price premiums. Those who are at least indifferent to the product were already filtered out and no longer belong to the discount sample. If never-switchers are small in number compared to the sample size, there is less harm in filtering them out. However, if they form a significant section of the sample, they ought to be modeled explicitly with a separate latent variable s^*, such that discounts are observed only when $s^* > 0$. One can specify the discrete outcomes of the discount elicitation using indicator variables as

$$
I_s = \begin{cases} 1, & \text{if } s^* > 0 \quad \text{where } s^* \sim F_s(k_s, \theta_s); \ \mathbb{E}[s^*|\mathbf{X_s}] = g_s(\mathbf{X_s}, \beta_\mathbf{s}) \\ 0, & \text{otherwise} \end{cases}
\tag{2.14}
$$

$$
I_d = \begin{cases} 1, & \text{if } d^* \leq B_L{'} \text{ and } s^* > 0 \quad \text{where } d^* \sim F_d(k_d, \theta_d); \ \mathbb{E}[d^*|\mathbf{X_d}] = g_d(\mathbf{X_d}, \beta_\mathbf{d}) \\ 2, & \text{if } B_L{'} \leq d^* < B_1{'} \text{ and } s^* > 0 \\ 3, & \text{if } B_1{'} \leq d^* < B_H{'} \text{ and } s^* > 0 \\ 4, & \text{if } d^* > B_H{'} \text{ and } s^* > 0 \\ \text{unobserved}, & \text{if } s^* \leq 0 \end{cases}
$$

$$
\text{where } F_{sd}(\rho_{sd}) = \begin{cases} F_s \times F_d, & \text{if } \rho_{sd} = 0 \\ C(F_s, F_d; \rho_{sd}), & \text{otherwise.} \end{cases}
$$

$$\tag{2.15}$$

Note that I_d is unobserved when $I_s = 0$ and accounts for the possibility of dependence in the two data generating processes. The likelihood for this model is similar to Equation 2.7 with F_e and F_p replaced by F_s and F_d respectively.

$$
\begin{aligned}
\mathcal{L}_d = & \prod_{I_s=0} \{F_s(0)\} \prod_{I_d=1} \{F_d(B_L) - C(F_s(0), F_d(B_L); \rho_{sd})\} \\
& \times \prod_{I_d=2} \{F_d(B_1) - F_d(B_L) - C(F_s(0), F_d(B_1); \rho_{sd}) + C(F_s(0), F_d(B_L); \rho_{sd})\} \\
& \times \prod_{I_d=3} \{F_d(B_H) - F_d(B_1) - C(F_s(0), F_d(B_H); \rho_{sd}) + C(F_s(0), F_d(B_1); \rho_{sd})\} \\
& \times \prod_{I_d=4} \{1 - F_d(B_H) - F_s(0) + C(F_s(0), F_d(B_H); \rho_{sd})\}
\end{aligned}
\tag{2.16}
$$

A special case of this model is the assumption that ρ_{sd} is 0 when C is replaced by the product of the marginal distributions F_s and F_d.

While the proposed modeling framework is most suited for measuring IWTP for PATs and analyzing consumer response to them, it can also be used broadly whenever a modification to an existing product is to be assessed as a whole. It is especially

useful when the broad market response to a product modification is expected to be heterogeneous. In the next section, I provide demonstrative applications of the modeling framework in assessing consumer response to the presence of a PAT to three different products and discuss its implications.

2.4 Empirical Application

I provide three empirical studies to demonstrate the usefulness of the proposed model. First, I estimate the IWTP for a laptop computer with a PAT (recycling and remanufacturing), similar to the product used for the pretesting in section 2.1. The objective of the study is to isolate the factors that impact negative, indifferent and positive valuations and provide validity to the modeling framework. Second, I estimate IWTP for a footwear with a PAT (recycling), a relatively low-value product. The objective is to replicate findings of the first study and demonstrate that heterogeneity in consumer responses are not specific to product type. Third, I estimate the IWTP for a headphone with a PAT using an improved version of the elicitation procedure that adds incentive compatibility to the stated WTP for the base product. I use an adapted BDM auction in a field study to replace the stated WTP for the base product with a more accurate measure of the consumer reservation price.

2.4.1 Study 1 - Laptop with Recycled/Remanufactured Components

Data. I used Amazon mTurk to recruit 637 survey participants to evaluate a low cost notebook computer that runs Google's web based chrome OS (the base product). I showed the participants a detailed description of the product's specification together with photographs. I also provided the current market price (both highest and lowest) based on selling price of the product in different online websites such as Amazon and

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the statistics relating to more than 5000 online consumer reviews. I then asked the participants to provide their maximum willingness to pay for the product if they were interested in buying and also indicated that they can provide a value of zero if they were not interested in buying the product at any price. I considered only those participants that provided a non-zero WTP for the base product for further participation. Others were simply asked demographic questions and received full compensation (just as any other participant). I showed the participants that had a non-zero WTP, the description of a new version of the same product. The new product was essentially the same product (specification, exterior design and warranty including the photographs) except that it was accompanied by additional information on how the product reduces environmental harm owing to the use of either recycled materials recovered from used products or remanufactured components of previously used products. In order to ascertain if the choice of wordings ('recycling' and 'remanufacturing') had an impact on the valuation, I randomly assigned participants to one of the two descriptions. The participants then responded to the same series of dichotomous choice ('yes' or 'no') questions that were shown in Figure 1 in order to estimate IWTP. The participants subsequently responded to a series of multi-item and dichotomous survey measures for validating the model. These variables are described in Table 3.

Expectation. Following the discussion in section 2.2, I expect consumers' concern about the product's quality (both functional and aesthetic combined), perception of cost savings on the firm-side, and expectation of price level based on market-based reference prices (i.e. lower for products with remanufactured components and higher for product with recycled material) to be the major drivers of negative valuation. Similarly, I expect consumers' concern for product level sustainability and consumers' attribution of responsibility for product level sustainability (i.e., the extent to which

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Table 3: Definitions of Independent Variables

Independent Variables	Definition
quality concern	The extent to which consumers think PAT affects product quality (both functional and aesthetic quality).
cost perception	1 if consumers perceives firm-side cost-saving using the PAT; 0 otherwise.
responsibility attribution	The extent to which consumers attribute responsibility for PAT to firms as opposed to themselves.
swtp	Stated WTP for base product as a proxy for base product's reservation price.
recycling_i	1 if recycled materials are used in products; 0 if remanufactured components are used.
sustainability	Consumers' preference for product level sustainability.
trust	Consumers' level of trust in firms' promotional claims.
gender	1 if male; 0 otherwise.
income	Annual income in 10K intervals or discretionary spending in 1K intervals.

Note: The multi-item measures are available as part of APPENDIX-B

consumers think the firm or the consumer is responsible for product level sustainability) and the WTP for the base product to be the prime drivers of positive valuation (i.e non-zero price premiums) and its magnitude. I controlled for consumers level of trust in the firms' marketing claims, and other demographic variables such as gender, age, household size, ethnicity, political affiliation, and income. The description of the products and the survey items are available as part of APPENDIX B.

I used a total of 443 responses that passed two tests of data validation (clearance of attention filters and test of manipulation with respect to use of words recycling and remanufacturing) for further analysis. Table 4 shows the discrete outcomes of the IWTP elicitation procedure and Table 5 shows the descriptive statistics of the measured independent variables. The reliability of multi-item measures were high (with the least being an α of 0.76) and the independent variables including the stated

Table 4: IWTP Elicitation Outcomes - Study 1 (Laptop)

Consumer Group	Recycling	Remanufacturing	Total
Non-Zero SWTP[†]	250	193	443
Premium Payers	172 (68.80%)	73 (37.82%)	245 (55.30%)
Indifferent	50 (25.50%)	47 (24.35%)	97 (21.90%)
Discount Buyers	25 (10.00%)	67 (34.71%)	92 (20.77%)
Non-Switchers	03 (01.20%)	06 (03.10%)	09 (02.03%)

Note: participants who failed the manipulation check were filtered out of the sample

† stated willingness to pay for the base product

WTP for the base product did not suffer from multicolinearity. For the 'attribution of responsibility' for product level sustainability, I computed a composite measure by subtracting consumer responsibility scores from firm responsibility scores i.e. those who thought that both the firm and consumers are equally responsible for product level sustainability will end up having 0 as their rating for the composite measure. Four respondents indicated whether they considered the new product equivalent to the base product but did not provide answers to the choice questions with price bids. I use this partial information for the likelihood estimation. However, I assume the sample size to be 439 for arriving at the degrees of freedom. While I do not set any a priori expectation on the dependence between the negative valuation and the price premium processes, a negative dependence will indicate that some consumers that are potentially high premium payers for PAT end up not considering the new product to be equivalent to the base product for reasons other than the public benefit alluded to by the PAT.

2.4.2 Model Selection and Estimation

The fraction of respondents that negatively responded to the PAT (20.77%) and the fraction of respondents that were indifferent to the PAT (21.90%) as shown in Table 4

Table 5: Descriptive Statistics - Study 1 (Laptop)

Variable[1]	Mean	SD	Min	Max
recycling	0.56	-	0	1
swtp	$211.61	$86.78	$50	$1000
cost perception	0.34	-	0	1
quality concern	3.56	01.83	1	7
sustainability	4.85	01.26	1	7
trust	4.83	00.97	1	7
responsibility attr$\sim$	1.50	01.03	-7	7
gender	0.58	-	0	1
annual income[2]	3.66	1.83	1	6

Note: see APPENDIX B for details on multi-item measures
[1] reliability for multi-item measures (α) > 0.76
[2] measured in $10K intervals; median in $40K - $50K$

are clearly large and cannot be neglected. Of the various models discussed in section 2.3, one can fit a bivariate model with zero inflation (in order to separately account for indifferent valuations), a bivariate model without inflation, and a univariate model that accounts for negative valuations and use a fitness criteria to choose the most appropriate model. I use the Akaike Information Criteria (AIC) (Akaike, 1974) with penalty for over parameterization. The model parameters for the three different models are estimated by minimizing the negative loglikelihood specified in Equation 2.8, 2.10, and 2.13 using numerical optimization. Specifically, I employ the two stage estimation procedure called the 'Inference Functions for Margins' (IFM) to estimate copula models (Joe, 2005). Apart from the convenient decoupling of the estimation of the dependence parameter ρ_{ep} from the rest of the parameters, the two stage procedure allows the researcher to perform diagnostic tests on distributional assumptions for univariate marginals in the first stage even before one specifies the dependence structure using a copula. In APPENDIX A, I explain the estimation procedure and delineate the results of monte-carlo simulations for different distributional assumptions.

Table 6: Price Premium Estimates - Study 1 (Laptop)

Variables	Model I			Model II		Model III
	Negative† (Normal) β_e	Indifference† (Normal) β_i	Premium (Gamma) β_p	Negative† (Normal) β_e	Premium (Lognormal) β_p	Censored Premium (Normal) β_p
intercept	$-1.44\,(0.21)^{**}$	$-0.96\,(0.23)^{**}$	$+2.98\,(0.21)^{**}$	$-1.44\,(0.27)^{**}$	$+3.12\,(0.30)^{**}$	$+11.87\,(0.98)^{**}$
recycling	$-0.58\,(0.18)^{**}$	$-0.30\,(0.18)^{\circ}$	$-0.05\,(0.17)$	$-0.58\,(0.16)^{**}$	$+0.16\,(0.13)$	$+3.23\,(0.90)^{**}$
swtp	$+0.05\,(0.10)$	$-0.22\,(0.11)^{*}$	$+0.02\,(0.07)$	$+0.05\,(0.10)$	$+0.11\,(0.08)$	$+0.47\,(0.63)$
cost perception	$+0.90\,(0.17)^{**}$	$+0.59\,(0.22)^{**}$	$-0.23\,(0.21)$	$+0.90\,(0.24)^{**}$	$-0.62\,(0.19)^{**}$	$-6.79\,(1.05)^{**}$
quality concern	$+0.70\,(0.10)^{**}$	$-0.00\,(0.18)$	$-0.15\,(0.12)$	$+0.70\,(0.11)^{**}$	$-0.14\,(0.09)$	$-4.07\,(0.55)^{**}$
sustainability	$-0.27\,(0.15)^{\circ}$	$-0.51\,(0.11)^{**}$	$+0.29\,(0.11)^{**}$	$-0.27\,(0.09)^{**}$	$+0.59\,(0.10)^{**}$	$+3.98\,(0.57)^{**}$
trust	$-0.07\,(0.16)$	$-0.12\,(0.15)$	$+0.01\,(0.12)$	$-0.07\,(0.10)$	$+0.06\,(0.08)$	$+0.49\,(0.23)^{*}$
responsibility attr~	$+0.06\,(0.09)$	$+0.29\,(0.11)^{*}$	$+0.02\,(0.17)$	$+0.06\,(0.09)$	$-0.16\,(0.09)^{\circ}$	$-0.95\,(0.40)^{**}$
gender	$-0.01\,(0.31)$	$+0.30\,(0.17)^{\circ}$	$-0.02\,(0.11)$	$-0.01\,(0.18)$	$-0.19\,(0.17)$	$-1.10\,(0.76)$
income	$+0.08\,(0.09)$	$-0.05\,(0.13)$	$+0.01\,(0.20)$	$+0.08\,(0.10)$	$+0.04\,(0.09)$	$-0.19\,(0.73)$
θ_p			$+2.74\,(1.49)$		$+1.05\,(0.15)$	$+9.24\,(0.53)$
ρ_{ep}			$-0.12\,(0.01)^{**}$		$-0.05\,(0.11)$	
Log Likelihood			-596.2594		-538.2655	-569.8109
AIC			$+1256.5$		$+1120.5$	$+1163.6$

$^{**}p < 0.01$ $^{*}p < 0.05$ $^{\circ}p < 0.10$

† The original model outcomes are of the opposite sign (non-negative and non-indifferent respectively) but changed for easier interpretation

Model I - Bivariate Model with Zero Inflation;   Model II - Bivariate Model without Zero Inflation;   Model III - Censored Univariate Model

N = 439

Table 6 shows the parameter estimates for price premiums using the three possible models. β_e shows the impact of covariates on whether a consumer will negatively value a product. β_v shows the impact of the covariates on whether a consumer will be indifferent to the PAT as opposed to paying a price premium. β_p shows the impact of covariates on the magnitude of price premium given a consumer is not indifferent. I report the results of the latent standard normal specification for modeling negative valuations and true indifference observations as they provide a better fit over the standard logistic specification. For the magnitude of price premiums, I report the results for Gamma specification (using a Weibull or Lognormal specification instead of Gamma does not alter the parameter estimates and yield similar loglikelihood values expect for differences in the estimates of the shape parameter). I report the estimate of ρ_{ep} for the Gaussian copula. The second model (bivariate model without zero inflation) provides that best fit for the data. However, it lacks the ability to distinguish between indifferent valuations (true zeros) and positive valuations. Similarly, Table 7

Table 7: Price Discount Estimates - Study1 (Laptop)

| Variables | Bivariate Model[1] | | Univariate Model[2] |
	Non-Switcher (Normal) $\beta_{\mathbf{s}}$	Price Discount (Lognormal) $\beta_{\mathbf{d}}$	Price Discount (Lognormal) $\beta_{\mathbf{d}}$
intercept	$-2.10\,(0.66)^{**}$	$+3.60\,(0.38)^{**}$	$+3.60\,(0.24)^{**}$
recycling	$-0.30\,(0.61)$	$-0.50\,(0.31)$	$-0.50\,(0.17)^{**}$
swtp	$+0.14\,(0.25)$	$+0.15\,(1.18)$	$+0.15\,(0.18)$
cost perception	$+0.75\,(0.75)$	$-0.82\,(0.47)^{\circ}$	$-0.82\,(0.48)^{*}$
quality concern	$+0.81\,(0.42)^{\circ}$	$+0.16\,(0.17)$	$+0.16\,(0.16)$
sustainability	$-0.41\,(0.25)$	$+0.08\,(0.20)$	$+0.08\,(0.22)$
trust	$-0.15\,(0.23)$	$-0.06\,(0.16)$	$-0.06\,(0.13)$
responsibility-attr	$-0.13\,(0.26)$	$+0.00\,(0.14)$	$+0.00\,(0.13)$
gender	$-1.64\,(0.65)^{*}$	$-0.15\,(0.24)$	$-0.15\,(0.27)$
income	$+0.09\,(0.31)$	$+0.06\,(0.15)$	$+0.06\,(0.14)$
θ_p		$+0.92\,(0.17)$	$+0.92\,(0.10)$
ρ_{ep}		$-0.07\,(0.05)$	
Log Likelihood		-120.9839	-100.7484
AIC		$+283.9678$	$+223.4968$

$^{*}p < 0.05$ $\qquad ^{**}p < 0.01$ $\qquad ^{\circ}p < 0.10$

[†] This model accounts for never-switchers as a separate group

[1] N = 100 $\qquad$ [2] N = 91 (after removing never switchers)

shows the parameter estimates for the price discounts on the restricted sample (those that negatively evaluated the PAT). I report the estimates of both a bivariate model that includes never-switchers as part of the estimation and a univariate model that discards never-switchers who comprised a small fraction of the total sample (2.03%). The univariate model for price discount provides the best fit.

Results. In line with expectations, the impact of the various covariates differ based on the dependent variable of interest. Column 2 of Table 6 shows the impact of covariates on the consumer propensity to view the PAT negatively. Concerns about product quality and firm-side cost perception (whether the consumer thinks that the

firm saves costs in the development of the new product) have the largest impact on negative valuation on PAT. Similarly, the presence of remanufactured components has a positive impact on negative valuation as opposed to the use of recycled materials recovered from used products indicating that reference prices play a role in negative valuations.

Column 3 of table 6 shows the impact of covariates on the propensity of the consumers to be truly indifferent to the PAT provided they had not valued them negatively. Column 4 shows the impact of covariates on the magnitude of price premiums. Column 6 shows the impact of covariates on premiums with indifferent zeros combined with price premiums. As expected, consumers' concern for product level sustainability, their stated WTP for the base product, and consumers' attribution of responsibility significantly influence price premiums. Additionally, variation in quality concerns and cost perceptions also play a role in determining if the consumer will pay a non-zero price premium. The univariate model (Model III) yields consistent results but is unable to distinguish between the impact of the covariates on negative valuations and indifferent valuations. Moreover, the dependence between the processes generating negative valuations and non-zero price premiums is negative, albeit small. To the extent one is able to measure all relevant variables and account for them in the model, this problem of dependence can be mitigated. In terms of marginal effects, a firm-side cost saving perception increases the proportion of negative valuations from $\approx 7.5\%$ to $\approx 29\%$ ceteris paribus. Similarly a one standard deviation increase in quality concern increases negative valuations from $\approx 7.5\%$ to $\approx 23\%$, a threefold increase. The price premium for an average consumer (at mean centered values for all covariates) is $\approx 17\$$ which is roughly 8% of the average price of the base product.

The average discount demanded by those that negatively valued the product is $\approx 36\$$ more than twice the magnitude of the average premium.

2.4.3   Study 2 - Flipflop with Recycled Material

As Study 1 involved a high value electronic product, the key objective of this study is to replicate the findings of Study 1 by verifying the existence of a heterogeneous response even for a relatively utilitarian low-value product. I retain the distributional assumptions but use a smaller sample size. I estimate the IWTP for PAT targeting environmental sustainability in a low cost footwear (Flipflop).

Data. I recruited participants to evaluate a low cost flip-flop through Amazon's mTurk. I followed the same protocol as in Study 1. However, I omitted the multi-item measure of 'consumer trust' to reduce the burden of a long survey (it did not have any impact on any of the choices of the different consumer groups in the main study involving laptops). The detailed description of the products and the survey questions are available as part of APPENDIX B.

I used a total of 239 responses that passed two tests of data validation (two questions that test whether participants pay attention to the contents of the survey) for further analysis. Table 8 shows the discrete outcomes of the IWTP elicitation procedure and Table 9 shows the descriptive statistics of the measured covariates. Participants were drawn from different age groups, income levels, and political views although certain ethnicities were underrepresented. The reliability of multi-item measures were sufficiently high (with the least being an α of 0.78). The independent variables including the stated WTP for the base product did not suffer from multi-collinearity. The variable 'attribution of responsibility' is computed as the difference between consumers' perceptions of firms responsibility and their own responsibility.

Table 8: IWTP Elicitation Outcomes - Study 3 (Flipflop)

Consumer Group	Responses
Non-Zero SWTP*	239
Premium Payers	137 (57.32%)
Indifferent	76 (31.80%)
Discount Buyers	19 (07.95%)
Non-Switchers	04 (01.67%)

* stated willingness to pay for the base product

Table 9: Descriptive Statistics - Study 2 (Flipflop)

Variable[1]	Mean	SD	Min	Max
swtp	$23.92	$09.53	$1	$50
cost perception	0.58	-	0	1
quality concern	2.56	01.49	1	7
sustainability	5.08	01.21	1	7
trust	4.05	00.81	1	7
responsibility attr~	1.46	1.81	-7	7
gender	0.63	-	0	1
income[2]	3.62	1.86	1	6

[1] reliability for multi-item measures $(\alpha) > 0.78$

[2] measured in $10K$ intervals; median is in $30K - $40K$

Three respondents indicated whether they considered the new product equivalent to the base product but did not provide answers to the choice questions with price bids. I use this partial information for the likelihood estimation. However, I assume the sample size to be 236 for arriving at the degrees of freedom.

Results. Similar to the laptop example, a large percentage of sample were indifferent to the presence of a PAT (31.80%) and more than half of the sample were willing to pay a price premium (57.32%). In contrast, only a small percentage of the sample did not consider the new product equivalent to the base product (7.95%) and just 4 consumers refused to consider buying the new product with the PAT at any discount

despite having a positive WTP for the base product. Table 10 shows the parameter estimates for price premiums using the three alternative models (Model I being the most elaborate accounting for negative valuations and inflation at zero owing indifferent valuations [12]). The impact of the covariates on the different dependent variables are largely consistent with the findings of Study 1. Also, I find a significant negative dependence between the process generating the negative valuation(the sample that considered the new product equivalent to the base product) and the process modeling the magnitude of price premiums. Some of those who negatively valued the product would have ended up paying an above average premium had they considered the new product with PAT equivalent to the base product. Discarding the negative dependence underestimates the consumers' positive valuation of the PAT. The premium-paying group paid an average premium of \$5.2 or $\approx 22\%$ of the base product's value. It is notable that I'm unable to replicate the impact of the stated WTP on the magnitude of the price premiums or on the propensity to pay non-zero premiums. While it is possible that the value of the base product does not impact the valuation of PAT in a low-value product, one cannot rule out the fact that a stated WTP is perhaps an unreliable approximation of the reservation price of the base product. I remedy this problem by introducing an enhanced version of the elicitation procedure and using it in a field study involving the sale of a headphone in the subsequent section.

2.4.4 Study 3 - Headphones with a PAT

While the empirical approach provides the ability to directly assess the impact of the reservation price of the base product on the IWTP for a PAT, a possible limitation

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[12]The negative valuation sample was not sufficient to estimate the minimum discounts as a function of consumer and product specific characteristics.

Table 10: Price Premium Estimates - Study 2 (Flipflop)

	Model I			Model II		Model III
	Negative†	Indifference†	Premium	Negative†	Premium	Censored Premium
	(Normal)	(Normal)	(Gamma)	(Normal)	(Gamma)	(Normal)
Variables	$\beta_{\mathbf{e}}$	$\beta_{\mathbf{i}}$	$\beta_{\mathbf{p}}$	$\beta_{\mathbf{e}}$	$\beta_{\mathbf{p}}$	$\beta_{\mathbf{p}}$
intercept	$-2.21\,(0.17)^{**}$	$-1.13\,(0.14)^{**}$	$+1.70\,(0.09)^{**}$	$-2.21\,(0.16)^{**}$	$+1.64\,(0.15)^{**}$	$+4.71\,(1.52)^{**}$
swtp	$+0.11\,(0.12)$	$+0.04\,(0.07)$	$+0.02\,(0.06)$	$+0.11\,(0.13)$	$+0.02\,(0.09)$	$-0.06\,(0.47)$
cost perception	$+1.01\,(0.10)^{**}$	$+0.87\,(0.16)^{**}$	$+0.01\,(0.09)$	$+1.01\,(0.15)^{**}$	$-0.33\,(0.10)^{**}$	$-1.60\,(1.01)$
quality concern	$+0.70\,(0.10)^{**}$	$-0.04\,(0.10)$	$-0.07\,(0.07)$	$+0.70\,(0.10)^{**}$	$-0.07\,(0.10)$	$-0.74\,(0.63)$
sustainability	$+0.13\,(0.09)$	$-0.55\,(0.10)^{**}$	$+0.14\,(0.10)$	$+0.13\,(0.12)$	$+0.38\,(0.08)^{**}$	$+0.85\,(0.50)^{\circ}$
responsibility-attr	$+0.18\,(0.13)$	$+0.07\,(0.09)$	$-0.03\,(0.05)$	$+0.18\,(0.13)$	$-0.06\,(0.07)$	$-0.26\,(0.26)$
gender	$-0.05\,(0.18)$	$+0.32\,(0.16)^{*}$	$-0.11\,(0.08)$	$-0.05\,(0.09)$	$-0.24\,(0.10)^{*}$	$-0.76\,(0.43)^{\circ}$
income	$+0.07\,(0.10)$	$+0.04\,(0.09)$	$+0.02\,(0.08)$	$+0.07\,(0.08)$	$-0.01\,(0.08)$	$-0.03\,(0.23)$
θ_p			$+5.23\,(0.68)^{**}$		$+1.55\,(0.14)^{**}$	$+2.68\,(0.18)^{**}$
ρ_{ep}			$-0.37\,(0.31)$		$-0.28\,(0.26)$	
Log Likelihood			-337.4412		-378.8325	-348.703
AIC			726.8824		691.665	715.406

$^{**}p < 0.01$ $^{*}p < 0.05$ $^{\circ}p < 0.10$

† The original model outcomes are of the opposite sign (non-negative and non-indifferent respectively) but changed for easier interpretation

Model I - Bivariate Model with Zero Inflation;   Model II - Bivariate Model without Zero Inflation;   Model III - Censored Univariate Model

N = 236

is the use of a stated maximum WTP as a proxy for the reservation price. An open ended stated WTP measure suffers from strategic overbidding or underbidding when it is not combined with an incentive for consumers to state the true maximum WTP (commonly referred to as 'incentive compatibility'). In this section, I show how the stated WTP measure for the base product can be replaced by an adapted BDM auction. BDM auctions are incentive compatible under risk neutrality assumption and therefore, the price bids are a closer approximation of the reservation price of the base products (Becker *et al.*, 1964). As the researchers need to execute a real business transaction, this approach is generally suited for low value products. I use a $200 worth headphones to estimate the IWTP for recycling/remanufacturing. The procedure for the field study, data, and the results of the analysis are as follows.

Procedure. Undergraduate business students at a major US public university were given an opportunity to buy a new $200 headphones at their own stated price (anywhere between $0 - $200). They were first required to submit their price bid after examining the product and then choose a random number between $0 - $200. If their

price bid was greater than the random number, they were enrolled in a raffle to buy the product at their stated price bid. If their price bid was lower than the random number, they forfeited the chance to buy the product. Students' price bid now replace their stated maximum WTP for the base product. It is in the best interest of the participants to state their true WTP under this scheme as overbidding can result in a real purchase of the product and underbidding can result in a missed opportunity to buy the product at their own maximum WTP. The original BDM auction scheme does not involve a raffle but this adapted version preserves incentive compatibility together with providing the ability to work with relatively high value products as only a few units are placed for sale (Ariely *et al.*, 2003; Fudenberg *et al.*, 2012). I sold two units of 'Beats by Dre' branded headphones using this procedure as they were found to be popular amongst students at the time of this research [13]. Another important variation from the previous study was the presentation of price bids in terms of percentage values. I used this variation as the pre-tests suggested that some students might think of premiums in terms of percentage values of the base product's price. The three bids sets were $\{2\%, 5\%, 10\%\}$, $\{5\%, 10\%, 15\%\}$, and $\{10\%, 15\%, 20\%\}$. These bids sets were later converted to dollar values using their auction bids for the base product. This method has the added advantage of increasing the variance in bid-sets as the same percentage value can result in a wide variety of dollar values depending on the consumers' maximum WTP for the base product.

Data. 365 students participated in the auction to purchase the headphones and all participants filled out a paper-based survey that elicited their IWTP for a new product that is similar to the headphones being sold in every way except that they

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[13]The advertisement, detailed demonstration of the procedure, and the recruitment of participants for this exercise were undertaken through the university's dedicated marketing behavioral lab.

Table 11: IWTP Elicitation Outcomes - Study 3 (Headphone)

Consumer Group	Responses
Non-Zero SWTP*	347
Premium Payers	206 (59.37%)
Indifferent	93 (26.80%)
Discount Buyers	41 (11.81%)
Non-Switchers	05 (01.44%)

* stated willingness to pay for the base product

had an additional PAT that targeted at reducing environmental pollution through recycling or remanufacturing (47% of the students were exposed to the word 'recycling' while the rest were exposed to the word 'remanufacturing'). I used a total of 347 completed responses for the estimation of IWTP. Two respondents indicated whether they considered the new product equivalent to the base product but did not provide answers to the choice questions with price bids. I use this partial information for the likelihood estimation. However, I assume the sample size to be 345 for arriving at the degrees of freedom. The survey also included multi-item measures similar to Study 1 to control for individual specific characteristics. Table 12 shows the descriptive statistics of the independent variables. The two winners of the raffle purchased the headphones at their stated prices $95 and $67 respectively.

Results. As a significant portion of the student participants failed to properly identify the difference between a recycled and a remanufactured product (27%), I collapsed the two conditions to estimate the IWTP for a PAT that targeted reduction in environmental pollution in general. 13.2% of the participants negatively valued the new product with PAT. The average age is 21.8 with little variation reflective of a student population. In Table 13, I report the results of estimating the three alternative models that are suitable for estimating price premiums. Once again, I replicate the

Table 12: Descriptive Statistics - Study 3 (Headphone)

Variable[1]	Mean	SD	Min	Max
recycling	0.43	-	0	1
swtp	$80.62	$44.10	$0	$300
cost perception	0.43	-	0	1
quality concern	3.40	01.56	1	7
sustainability	4.37	01.42	1	7
responsibility attr~	1.51	01.67	-7	7
gender	0.59	-	0	1
discretionary spending[2]	2.99	1.64	1	6

[1] reliability for multi-item measures (α) > 0.69

[2] measured in $1K$ intervals; median is in $3K - $4K$

Table 13: Price Premium Estimates - Study 3 (Headphone)

	Model I			Model II		Model III
	Negative[†]	Indifference[†]	Premium	Negative[†]	Premium	Censored Premium
	(Normal)	(Normal)	(Gamma)	(Normal)	(Gamma)	(Normal)
Variables	β_e	β_i	β_p	β_e	β_p	β_p
intercept	$-1.67\,(0.15)$**	$-0.80\,(0.12)$**	$+2.05\,(0.13)$**	$-1.67\,(0.10)$**	$+1.90\,(0.11)$**	$+6.96\,(0.70)$**
swtp	$+0.15\,(0.08)$°	$-0.16\,(0.06)$*	$+0.56\,(0.06)$**	$+0.15\,(0.07)$*	$+0.64\,(0.06)$**	$+3.01\,(0.41)$**
cost perception	$+0.68\,(0.25)$**	$+0.33\,(0.16)$*	$+0.09\,(0.13)$	$+0.68\,(0.12)$**	$-0.07\,(0.08)$	$-1.50\,(0.64)$*
quality concern	$+0.33\,(0.14)$*	$+0.06\,(0.09)$	$-0.11\,(0.06)$°	$+0.33\,(0.07)$**	$-0.15\,(0.05)$**	$-1.09\,(0.37)$**
sustainability	$-0.12\,(0.10)$	$-0.30\,(0.09)$**	$+0.05\,(0.08)$	$-0.12\,(0.08)$	$+0.16\,(0.05)$**	$+1.05\,(0.70)$
responsibility-attr	$-0.12\,(0.13)$	$+0.12\,(0.09)$	$-0.02\,(0.05)$	$-0.12\,(0.07)$°	$-0.06\,(0.08)$	$+0.09\,(0.48)$
gender	$+0.00\,(0.20)$	$+0.20\,(0.13)$	$+0.05\,(0.18)$	$+0.00\,(0.10)$	$-0.01\,(0.13)$	$-0.47\,(0.78)$
income	$+0.09\,(0.07)$	$+0.06\,(0.11)$	$+0.08\,(0.06)$	$+0.09\,(0.06)$	$+0.06\,(0.05)$	$+0.04\,(0.40)$
θ_p			$+2.85\,(0.34)$		$+1.11\,(0.08)$	$+6.82\,(0.36)$
ρ_{ep}			$+0.03\,(0.08)$		$+0.01\,(0.05)$	
Log Likelihood			-580.682		-565.437	-663.717
AIC			$+1213.4$		$+1166.9$	$+1345.4$

**$p < 0.01$ *$p < 0.05$ °$p < 0.10$

[†] The original model outcomes are of the opposite sign (non-negative and non-indifferent respectively) but changed for easier interpretation

Model I - Bivariate Model with Zero Inflation;   Model II - Bivariate Model without Zero Inflation;   Model III - Censored Univariate Model

N = 345

finding that different factors drive the different types of consumer response to PAT with the direction and significance largely consistent with previous studies. I find the significant impact of the reservation price of the base product, the effect I failed to replicate in Study 2. Of those who are not indifferent to the PAT, an average study participant is willing to pay a premium of $6.69 or $\approx 8\%$ of the average price of the base product.

2.5 General Discussion

The proposed method of estimating incremental willing to pay for PATs provides three key advantages over existing methods prevalent in the literature. First, I account for positive valuations, indifferent zeros, negative valuations, and non-switching behavior within a single modeling framework that is flexible enough to allow for a wide variety of distributional assumptions for price premiums and discounts. Second, I allow for different processes to drive each type of consumer reaction i.e. both the selection and specification of covariates that drive each type of consumer reaction can be different. This allows for capturing the consumer heterogeneity in the impact of covariates and consequently, allows for product managers to follow different promotion and pricing strategies for each class of consumers. Third, I jointly estimate price premiums with negative valuations using a bivariate copula to account for the fact that some consumers that refused to buy the new product at their stated price for the base product may do so for reasons that are not directly related to the public benefit they allude to i.e. account for the correlation (or more generally, dependence) between the unobservables that drive both processes. This avoids a potential underestimation of the positive valuation of PAT in the sample. Coupling the estimation of price discounts with premiums enables product marketers to price discriminate where the primary objective is to maximize sales.

The empirical applications provide a clear case for promoting new products with PATs in such a way as to avoid consumer perception of firm-side cost savings or a product quality interference. This can be achieved by communicating firm side investments to develop PATs in new products and by partnering with third party agencies that guarantee equivalence in quality with conventional products. Luchs *et al.* (2010) show that an explicit stamp of guarantee of product efficacy positively impacts

consumer preference for sustainable product alternatives. Additionally, I provide empirical evidence for the notion that firms do not set prices for sustainable product alternatives (such as remanufactured products) on the basis of consumer demand. The magnitude of price premiums for the premium paying class of consumers did not differ based on how the PAT was incorporated in the product (recycling/remanufacturing). $\approx 40\%$ of the market participants in each study were either indifferent to the presence of a PAT or felt that the PAT took away from the base product thus threatening mainstream adoption of sustainable product development by firms. If firms neither gain subsidies nor avoid penalties arising out of government legislation to support sustainable practices such as recycling and remanufacturing, this is detrimental to profits. On the other hand, estimates of consumer demand for targeting a niche segment can be misguided if consumer heterogeneity is discarded. The proposed method provides a tool to assess the heterogeneous response of the market to PATs in new products.

Another important application of the proposed method is in the area of behavioral research where boundary conditions for consumer reactions to prosocial product attributes are tested. Behavioral studies that lean on laboratory experiments either use product choice or a direct WTP measure to quantify the dependent variable. However, not accounting for within group heterogeneity in consumer reactions can be severely detrimental when consumers are composed of those that react in diametrically opposite ways to the same manipulation. Random assignment to experimental settings will fail to alleviate this problem if the population has an equal proportion of both premium payers and discount buyers together with the truly indifferent. Despite any real and significant impact of the treatment, the average main effect can tend to zero. Because the suggested procedure involves not more than five questions to quantify

premiums or discounts, using the suggested elicitation procedure can alleviate this problem with minimal additional burden on participants. This is akin to having consumer types as interaction variables where the consumer types are determined indirectly.

I acknowledge a few important limitations of this paper. The elicitation procedure described in this paper is built on the sequential choice based contingent valuation procedure allowing for price premiums and discounts to be estimated as latent variables. As it mitigates the problem strategic overbidding (or underbidding), this approach is the most preferred in the contingent valuation literature (Carson *et al.*, 2001). However, I still cannot absolutely guarantee incentive compatibility (Cummings *et al.*, 1995). A customer can choose to provide affirmative answers to price bids of any magnitude and shift the mean of the latent variable that captures the price premiums to the right. Empirical evidence that confirms the threat of the lack of incentive compatibility to realistic estimates of WTP is mixed. Contrary to expectations, WTP studies that account for incentive compatibility on PATs (32 of roughly 174 observations in 81 different published papers) report higher percentage price premiums than methods that do not have incentive compatibility (Tully and Winer, 2014). Possible explanations include auctions inducing higher competitiveness among participants resulting in overestimation and in the case of revealed preferences, consumers relying on price premium anchors i.e. prices chosen a priori by firms (Ku *et al.*, 2005, 2006). Moreover, as auction based incentive compatible procedures rely on an eventual true purchase or compensation, researchers are forced to use low value products. This is detrimental to the valuation exercise as I have shown that the stated WTP for the base product has a significant impact on consumer reaction to the PAT. Yet, strengthening incentive compatibility to the proposed method while preserving the benefits will be a worthwhile

exercise for future research. Moreover, I have primarily relied on survey data for the empirical validation of the modeling approach but the causal identification of independent variables requires controlled experiments. I hope that the proposed model will be used in future behavioral work that seeks to identify causal drivers of a heterogeneous consumer reaction to PATs in new products.

The estimation of the demand-side value of PATs in products can be biased owing to consumers' perceptual variations resulting in ambivalent or indifferent responses. I demonstrated that distinguishing between the different classes of consumers that might react differently to the same PAT while modeling the IWTP has implications for both theory and managerial application in price setting and designing of promotional material. I also believe that I have added a new tool to the incremental willingness to pay estimation toolbox. I hope this research assists both survey researchers and experimental behavioral researchers in their assessment of consumer response to 'new product development' strategies.

Chapter 3

CONSUMER RESPONSE TO PAY-WHAT-YOU-WANT PRICING DESIGNS

3.1   Introduction

Pay-What-You-Want (PWYW) is an innovative pricing mechanism where firms let consumers decide prices for themselves thus relinquishing one of the most important managerial decisions that are central to running a profitable business. Non-profit organizations that have market-penetration as the sole objective have long used this option to tap a large customer base, but recently, many businesses with profit motive have adopted PWYW with success. A wide variety of both products and services such as digital books, headsets, music albums, copyrights, aftermarket support services, restaurants, and even business consulting services are currently using the PWYW mechanism[14]. Recent literature in this area has largely focused on why consumers tend to voluntarily pay under this mechanism. Using field experiments and controlled experiments in the lab, researchers have identified myriad causes pertaining to consumers' social preferences such as fairness-concern, inequity aversion, reciprocity, warm-glow together with more purely self-interested reasons such as self-image and identity concerns, strategic self-interest etc. (Kim *et al.*, 2009; Schmidt *et al.*, 2014; Chen, 2009). Previous research has also shown that anonymity of payments and product ties with charitable causes influence consumer PWYW payments (Gneezy *et al.*, 2010, 2012). The major objective of this paper is to demonstrate that consumers

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[14]A sample list of businesses (trademark names) that have used PWYW pricing to sell their products: Radiohead, Panera Bread, Larion Studios, Humble Bundle, Magnatune, Everlane, OpenBooks, Perlin Winery, Zoho

systematically differ in how they respond to PWYW pricing and that managerially controllable variables such as anonymity of payments, information on product quality variation, and information on payment recipients have a differential impact on the different types of consumer responses. To this end, I use a flexible statistical model that accounts for both variation in consumer response to PWYW and variations in the PWYW pricing design. The latter is especially important as businesses have more recently adapted the PWYW mechanism to include design constraints that influence payments such as the setting of price bounds (minimum/maximum prices), price recommendations (Johnson and Cui, 2013), and discretized price menus that allow consumers to choose from a list of prices instead of simply stating a price of their choice.

The key strength of the PWYW mechanism is its ability to accommodate a market with a large variance in the consumers' maximum Willingness-To-Pay (WTP) distribution. As a result, heterogeneity in payments is inherent by design. However, consumers can choose to respond in three major ways. First, a potential problem with removing the fixed price is the consumer-side cost associated with computing a fair-price for the product especially in the absence of a reference price or when sufficient information to value the product is unavailable. Consequently, consumers can choose to default to a reference price whenever they are available in order to avoid the valuation exercise even though they have the freedom to choose any price they want. This reference could be a recommendation price that is explicitly stated by the firm or a price that consumers are able to observe or inquire as a most frequently paid price by other consumers. Consumers defaulting to the recommendation price can potentially reduce revenue if some of their WTP were higher than the recommendation i.e. they might have paid more had there not been a reference price. Alternatively,

some consumers that had a WTP less than the recommendation may either choose to increase their payments or be discouraged to participate in the mechanism. Second, the consumer can decide to pay nothing at all in exchange for the product especially in cases where a certain level of anonymity is available for the consumer (e.g. online payments). PWYW is not viable if a large proportion decides to free-ride [15]. Third, consumers can decide to freely choose a non-zero price. It is important to note that such a freely-chosen price is not the same as their maximum WTP for the product exchanged. It can be thought of as a maximum WTP to negate the guilt of not paying adequately or to enjoy the warm-glow in having been kind to someone voluntarily. In this paper, in order to examine the differential impact of managerially controllable variables on different consumer groups, I consider the consumer propensity to default to a reference price, propensity to pay a freely-chosen price including the decision to pay the minimum legitimate price (including zero) as separate but dependent processes.

Just as consumer responses are heterogeneous, businesses have adopted a variety of designs to influence consumers. In addition to stating explicit recommendations, business can set minimum/maximum prices and offer discretized price menus to aid consumer decision making. Where discrete choices are made available, it is typically accompanied by an option to choose a price that is not part of the price menu. For instance, an online PWYW setting can have discrete choices $5, $10, $15, $20, and an option to state a different price between $20 and $40. Designs like these produce highly censored data. For instance, a consumer choosing the price $10 from the menu has a

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[15]In cases where sellers set a small non-zero price as the minimum legitimate price, the term 'free-rider' is perhaps a harsher term to use. However as many PWYW settings allow for consumers to pay nothing at all, for simplicity I use the term to indicate those who end up paying the absolute minimum.

WTP more than \$5 but less than \$15. Similarly, a consumer choosing \$40 has a WTP greater than or equal to \$40. In this paper, I account for explicit recommendations, price bounds, discrete price menus and continuous prices in the most general case with special cases accommodating simpler designs.

Using a secondary data analysis, supporting event analyses, and two different experimental analyses — all involving real PWYW payments and the proposed modeling approach, I show that:

1. Consumer tendency to default to a reference price increases when they lose payment anonymity. As a result, an explicit recommendation price can be used to drive PWYW payments upward where managers cannot guarantee anonymity.

2. Consumers adjust their payments in response to descriptive information on payment recipients. Managers can benefit by describing why recipients are deserving of fair payments without resorting to product association with charitable causes.

3. Consumers positively respond to information indicating value addition by sellers confirming that PYWY payments are not merely token prices to avoid guilt. This response is notable among those that chose to pay their own price without regard to price recommendations.

4. When an explicit recommendation price is not available, consumers tend to use others' payments as a price recommendation in public settings.

5. A low recommendation price can pull down PWYW payments but can also enhance participation by attracting new customers. Therefore, PWYW with an accompanying low price recommendation can increase market participation.

This essay makes two distinct contributions to the current literature on PWYW pricing. First, I examine variations in consumer response to PWYW pricing and show that managerially controllable variables can have differential impact on different

consumer groups providing a nuanced insight into the workings of the PWYW pricing mechanism heretofore missing in the literature. Second, by providing a flexible statistical modeling framework that accounts for both variations in consumer response to PWYW and variations in PWYW pricing design, I provide a tool for empirical researchers to analyze large volumes of discrete and continuous data generated on PWYW payments in the market place. The same approach can be used to analyze consumer WTP in other voluntary payment settings such as in the case of charitable contributions and tipping where design variations such as recommendation prices and discretized price menus are used. In § 3.2, I briefly discuss the drivers of variations in consumer response and the theoretical rationale behind the influence of the managerially controllable variables on different consumer groups. In § 3.3, I introduce the empirical approach to account for design variations in PWYW, the modeling framework, and the estimation procedure. In § 3.4, I first validate the model using a large secondary dataset comprising real PWYW payments followed by two event analyses and two experimental studies involving real PWYW payments under two different product contexts (snack sale and college basketball ticket sale). In § 3.5, I discuss my findings, implications for theory and practice, and finally conclude by acknowledging limitations and offering suggestions for future research.

3.2 Theory and Empirical Approach

3.2.1 Heterogeneous Consumer Response

In this section, I delve into the theoretical rationale behind the three types of consumer responses to a PWYW pricing design before analyzing how managerially controllable variables can influence them. First, I propose that a significant proportion of the consumers facing a PWYW setting will choose to default to a reference price to avoid

the cost of computing a fair price. This behavior is exacerbated when consumers have a high level of 'fairness concern' or 'image concern', two of the key behavioral drivers of payments in PWYW setting. The former can be thought of as payments to avoid the disutility of an unfair exchange while the latter can be thought of as payments to avoid others' judgment detrimental to personal image or identity. Kim *et al.* (2009) show that consumer 'fairness concern' significantly impacts PWYW payments in a restaurant setting. Consumer concern for fairness has been used as a central construct in both analytical and experimental work in behavioral economics (Kahneman *et al.*, 1986; Thaler, 1985; Fehr and Schmidt, 1999; Rabin, 1993). Similarly, Gneezy *et al.* (2012) show using a field experiment that 'image concern' significantly alters both consumer decision to participate and pay in a PWYW setting. Businesses selling products that are hard to be valued (e.g. digital products) can benefit from a PWYW design that incorporates an explicit recommendation price to mitigate the problem of fair price computation. Price determination is costly for consumers both in terms of the cognitive effort required (Shugan, 1980) and the possible negative affect owing to the uncertainty associated with whether or not a fair price is chosen.

Second, I propose that a proportion of consumers will choose to pay the minimum legitimate price (including zero when the PWYW design does not include a non-zero minimum price). This can be explained as the existence of a free-riding segment that is not motivated enough by social preferences such as 'fairness concern' or 'inequity aversion'. Research examining the profitability conditions for PWYW pricing assumes this proportion to be small or negligible for the viability of the pricing mechanism (Chen, 2009) . However, the size of this proportion is left to empirical observation contingent on business context. For instance, under conditions of perfect anonymity, even consumers driven solely by image concerns may choose to free-ride thus increasing

the size of this segment. This segment may also be larger in certain product categories (e.g. digital products) prone to hard-core piracy. Sinha *et al.* (2010) show that hard-core pirates do not convert to payers even under extremely favorable pricing conditions. Similarly, one-time buyers might free ride-more than consumers that intend to return and buy again from the same seller.

Third, I propose that a proportion of consumers will end up paying a price that is freely-chosen (i.e. neither defaulting to a reference price nor paying the minimum legitimate price). These consumers are able to determine a price based on their subjective valuation of the service or product. As this price is individual specific, the factors that influence the magnitude of the freely-chosen price is important to develop a PWYW design that enhances revenues. If this is a token price that consumers pay merely to avoid the guilt of free-riding, managers can do little to influence the magnitude of payments. However, findings from the nascent literature on PWYW provides preliminary evidence that consumers actively evaluate the product/service and adjust the magnitude of their payments accordingly. For instance, Kim *et al.* (2009) show that 'satisfaction' conceptualized as post-consumption evaluation of perceived quality significantly influenced PWYW voluntary payments in a restaurant setting. Similarly, Gneezy *et al.* (2010) show that products that are explicitly tied to a social cause elicited more revenue in a PWYW setting. Extending this line of research, I propose that the magnitude of freely-chosen payments can be influenced by managerial intervention.

3.2.2 Impact of Managerially Controllable Variables

Payment Anonymity: When payments are anonymous, the PWYW exchange is private to other customers, sellers, and payment recipients [16]. Although complete anonymity is hard to guarantee, sellers can provide a high degree of anonymity in the online purchase environment [17]. As image and identity concerns increases when consumers lose payment anonymity, I expect that consumer propensity to default to a reference price increases in public settings. Similarly, I expect a decrease in the propensity to free-ride. However, the impact of the loss of anonymity on the expected value of the freely-chosen prices is likely to be less pronounced as any increase in payments is counter-balanced by the payments of those that were previously paying the minimum legitimate price.

Information on Payment Recipients: Although previous research has shown that tying a product with a charitable cause enhances revenues in a PWYW settings, I propose that any information (not necessarily charity-related) on the final recipients of payments that enhances the moral intensity of the exchange will significantly impact the heterogeneous consumer response to PWYW. Jones (1991) in his influential work on ethics defines the concept of 'moral intensity' as the "..extent of issue related moral imperative in a situation" and considers the magnitude, likelihood, and proximity of effects in a given situation as its key determinants. According to this conceptualization, consumers might have a heightened moral intensity when the recipients are identified in terms of individuals as opposed to a general group (magnitude), when the possible

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[16]I distinguish between sellers and recipients because in some cases the seller might indicate that some of the proceedings of the PWYW sale will benefit other entities (e.g. a charitable organization). In many cases, the seller and the recipient are the same entity.

[17]When buyers use their credit cards, the sellers are not entirely privy to the buyer identity. However, an online environment is relatively more private than the physical shopping environment.

consequences for recipients are clearly explained (likelihood), and when recipients are identified as someone similar to them (proximity). For instance, when the eventual recipients of their PWYW payments are identified as a local business owner as opposed to a major national brand or a college student as opposed to an high net-worth individual, they are likely to increase their payments. More specifically, I expect the propensity to free-ride to decrease, and the magnitude of freely-chosen prices to increase. Also, some consumers that chose to default to a reference price owing to uncertainty about the fair price might decide to pay a higher freely-chosen price as they now tend to value the benefit to the recipient in addition to the value from the product itself.

Communicating Product Value: Apart from image/identity concern, lack of information to value a product contributes to the cognitive load of arriving at a fair price. Therefore, I expect that consumer propensity to default to a reference price will decrease as explicit quality information is available. Assessment of product value is however contingent on the business context. In the case of a digital product, it might simply amount to gleaning information on the product attributes whereas in the case of a service setting like restaurant, consumers can directly experience the product/service to make an assessment. Some PWYW pricing designs allow for payment to be made after consumption (post-paid) thus increasing the chances that prices reflect consumers' subjective valuation of the product. I expect that consumers' subjective value perception based on either their consumption experience or their perceived value owing to firm communication will influence payment decisions. Specifically I expect the consumer propensity to pay the least legitimate price (free-ride) to decrease and the variations in the magnitude of the freely chosen price to be explained in part by consumers' subjective value perception. However, the net-effect

effect of this on revenues (both magnitude and valence) will be contingent on the value assessment of the individual consumer. In a post-consumption PWYW scenario, consumer assessment of low value or bad quality can adversely affect both payment magnitudes and the proportion of free-riders.

3.2.3 An Empirical Approach

Equation 3.1 captures the heterogeneous consumer response in a typical PWYW setting that includes an explicit recommendation as a reference price.

$$\mathrm{P} = \psi P_r + (1 - \psi)[\phi \times P_m + (1 - \phi)P_f]. \tag{3.1}$$

P is the distribution of the PWYW payments. ψ is the proportion of consumers that choose to default to a fixed reference price P_r, ϕ is proportion of those who pay the minimum legitimate price P_m (this could be zero), and P_f refers to the freely-chosen price of the proportion of consumers that neither defaulted to a reference price nor paid the minimum legitimate price. The proportion is given by $(1 - \psi)(1 - \phi)$. P_f is assumed to be a random variable with non-negative support.

With the simple split-population structure of equation 3.1 as a starting point, one can now model the proportions ψ, ϕ and the expected value of P_f as functions of relevant covariates. Although one can test the impact of a wide variety of contextual and managerially controllable variables on the heterogeneous consumer response, I choose three variables that have been previously shown to have an overall impact on PWYW payments, namely, 'Payment Anonymity', 'Payment Recipient Information', 'Product Value/Quality Information'. Apart from being theoretically relevant, these are also variables that can be controlled by managers with relative ease as opposed to contextual variables such as product/service type, consumer demographics etc. It

is important to note that a section of the market might choose not to participate and P is the payment distribution of only those that decided to participate. Also, the freely-chosen payment P_f can in turn be a multi-modal distribution comprising multiple segments. I omit these two aspects for ease of exposition at this stage. I later accommodate the market participation process by adapting the base model in section § 3.4.

Before I proceed to test the impact of the chosen variables on the heterogeneous consumer response, I first propose a simple yet flexible statistical model that builds on equation 3.1 in the following section. I then elaborate on adding covariates to the model, discuss model estimation and adaptation to include design variations that include discretized price menus. I validate the model using real world data in the subsequent sections.

3.3 Statistical Model

In this section, I specify a statistical model that closely mimics the consumer's decision making process and helps estimate the heterogeneous consumer response to PWYW pricing as specified in equation 1 of § 3.2. I first start with the decision of market participants i.e. those who decided to participate in the exchange and include the participation process later. Faced with a decision to arrive at a price for the product/service, the consumer can simply bypass the effort by choosing to pay a reference price. I assume an explicit recommendation price P_r set by the seller for simplicity[18]. In order to model this process of choosing to pay a recommendation, I assume a latent variable r^* representing the propensity to default to a reference price

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[18]In my exploratory survey of potential PWYW consumers, some participants indicated that they would actively seek a reference price to make the task easier either by asking the seller for the cost/fair price or by inquiring about what others tended to pay. Managers use a variety of

such that if $r^* > 0$, the consumer pays P_r. If $r^* < 0$, the consumer ends up paying a price P_p of their liking. In order to capture the decision of some to not pay anything at all (or the minimum legitimate price if there exists one), I assume another latent variable m^* such that when $m^* > 0$ and $r^* < 0$, the consumer decides to pay the minimum price P_m (in most cases, $P_m = 0$). m^* represents the consumer propensity to free-ride. Equation 3.2 captures the PWYW payments as a result of a tripartite process model.

$$
P = \begin{cases}
P_r, & \text{if } r^* > 0 \quad \text{where } r^* \sim F_r(k_r, \theta_r); \ \mathbb{E}[r^*|\mathbf{X_r}] = g_r(\mathbf{X_r}, \beta_\mathbf{r}) \\
P_m, & \text{if } r^* \leq 0 \text{ and } m^* > 0 \quad \text{where } m^* \sim F_m(k_m, \theta_m); \ \mathbb{E}[m^*|\mathbf{X_m}] = g_m(\mathbf{X_m}, \beta_\mathbf{m}) \\
P_p, & \text{otherwise} \quad \text{where } P_p \sim F_p(k_p, \theta_p); \ \mathbb{E}[P_p|\mathbf{X_p}] = g_p(\mathbf{X_p}, \beta_\mathbf{p})
\end{cases}
\tag{3.2}
$$

$$
\text{where } F_{rp}(\rho_{rp}) = \begin{cases}
F_r \times F_p, & \text{if } \rho_{rp} = 0 \\
C(F_r, F_p; \rho_{rp}), & \text{otherwise.}
\end{cases}
$$

r^*, m^*, and P_p are modeled as random variables with distributions F_r, F_m, and F_p whose expected values can in turn be specified as a function of covariates X_r, X_m, and X_p respectively. k_r, k_m, and k_p correspond to the independent parameters of two parameter distributions while g_r, g_m, and g_p correspond to link functions respectively. Table 14 shows the different options for link functions, independent parameters, and cumulative distribution functions for the three variables. F_r and F_m are modeled either as a standard normal (like a Probit model) or as a standard logistic (like a Logit model) whereas F_p is modeled as a distribution with non-negative support convenient to model prices such as the Gamma, Weibull, Lognormal, or a Loglogistic distribution. In the general form, I also recognize that the decision to pay a freely-chosen price (as

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approaches to set an explicit recommendation. It could simply be the hard-cost or the average of what consumers freely chose to pay prior to setting a recommendation.
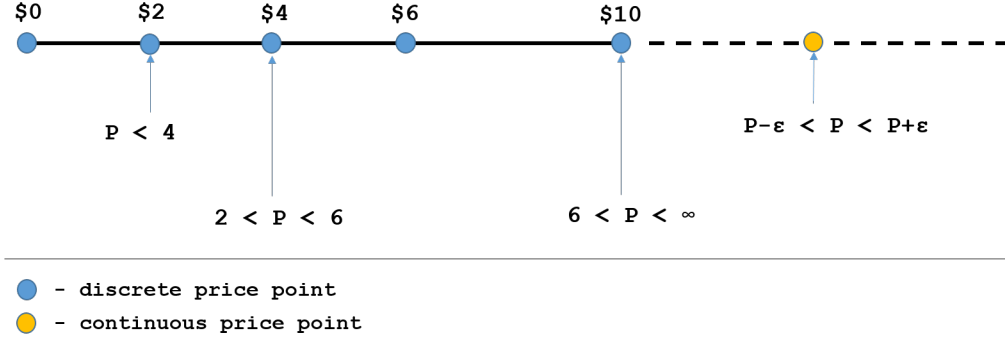
Figure 2: Imaginary price points

opposed to defaulting to a recommendation) and the magnitude of the freely-chosen price are likely to be correlated. In order to capture the dependence between the processes, I specify a copula function C that takes the marginal distributions F_r, F_p and a dependence parameter ρ (the rank correlation) as arguments and specifies a joint distribution of r^* and P_p. I use a copula function to accommodate dependence between dissimilar marginals (Sklar, 1973), a technique now widely used in marketing research (Danaher and Smith, 2011). It is important to accommodate the dependence structure to avoid biased estimates of consumer WTP. Some of those that defaulted to a recommendation price might have paid a freely chosen price had there not been an explicit recommendation indicating a possible sample selection issue in estimating average P_p. Now, the likelihood function for equation 3.2 can be written as

$$
\begin{aligned}
\mathcal{L}_p = \prod_{P_r}\{1 - F_r(0)\} \prod_0 \{F_r(0) - F_r(0)F_m(0)\} \\
\times \prod_{P_p}\{F_m(0)\frac{\partial}{\partial P_p}C(F_r(0), F_p(P_p); \rho_{rp})\}.
\end{aligned}
\tag{3.3}
$$

This likelihood assumes that prices are freely chosen in the interval $[0, \infty]$. However, most PWYW designs use a menu of discrete prices that consumers can select from in addition to providing an option to enter their own price. In order to accommodate

this aspect of the pricing design, one can consider the consumers' WTP (or the freely chosen payment P_p) as a value that lies within two price bounds, a upper limit $P_p{}^u$ and a lower limit $P_p{}^l$. For instance, figure 2 shows a continuous price line with several discrete price points \$2, \$4, \$6, and \$10 for illustration. Now, when a consumer chooses \$4 option, one can consider this as P_p lying somewhere between \$6 and \$2 i.e., $2 < P_p < 6$. Similarly, when a consumer chooses to pay \$2, P_p lies between \$0 and \$4. Whenever, there is an additional option to choose a payment outside of the menu of discrete prices, the payment P_p can once again be considered as a value that lies within a small interval of size ϵ such that $P - 0.5\epsilon < P_p < P + 0.5\epsilon$. Alternatively, if the seller decides to exclusively use discrete price menus without providing an option for consumers to state their own price, whenever the consumer chooses the maximum price available in the list say P_{max}, one can consider the bounds for the payment as $P_{max} < P_p < \infty$. One can now rewrite equation 3.3 as

$$
\begin{aligned}
\mathcal{L}'_p = \prod_{P_r}\{1 - F_r(0)\} \prod_0 \{F_r(0) - F_r(0)F_m(0)\} \\
\times \prod_{P_p} F_m(0) \left[C(F_r(0), F_p(P_p^u); \rho_{rp}) - C(F_r(0), F_p(P_p^l); \rho_{rp}) \right].
\end{aligned}
\tag{3.4}
$$

where $P_p{}^l < P_p < P_p{}^u$. This way of coding payments is also theoretically more appealing as consumer WTP can also be conceptualized as a range of values instead of point estimates (Wang *et al.*, 2007). Finally, as the interval $[P_p{}^u - P_p{}^l] \to 0$, equation 3.4 reduces to equation 3.3.

There are two major considerations for selecting a functional form for the copula function C. First, its ability to capture the dependence uniformly along the entire range of the marginal distributions and second, its ability to be robust to any misspecification of the joint distribution (Trivedi and Zimmer, 2007). The Gaussian copula satisfies both

Table 14: Latent Price Specification

Latent Variable	Type	$g(\mathbf{X}, \beta)^{\star}$	$k(g, \theta)^{\#}$	$\theta^{\dagger}$	$F(k, \theta)^{\ddagger}$
r^*, m^*	Normal	$\mathbf{X}\beta$	g	1	$\frac{1}{2\pi} \int_{-\infty}^{\frac{x-k}{\theta}} e^{\frac{-t^2}{2}} \, \mathrm{d}t$
	Logistic	$\mathbf{X}\beta$	g	1	$\frac{1}{1+e^{-\frac{x-k}{\theta}}}$
P_p	Gamma	$e^{\mathbf{X}\beta}$	$\frac{g}{\theta}$	estimated	$\frac{1}{\Gamma(k)} \gamma(k, \frac{x}{\theta})$
	Lognormal	$e^{\mathbf{X}\beta}$	$\ln(g) - \frac{\theta^2}{2}$	estimated	$\frac{1}{2\pi} \int_{-\infty}^{\frac{\ln(x)-k}{\theta}} e^{\frac{-t^2}{2}} \, \mathrm{d}t$
	Loglogistic	$e^{\mathbf{X}\beta}$	$g \times \frac{\theta}{\pi} \sin(\frac{\pi}{\theta})$	estimated	$\frac{1}{1+\left(\frac{x}{k}\right)^{-\theta}}$
	Weibull	$e^{\mathbf{X}\beta}$	$\frac{g}{1+\Gamma(\frac{1}{\theta})}$	estimated	$1 - e^{-\left(\frac{x}{k}\right)^{\theta}}$

* functional form of the expected value $^{\#}$ parameter dependent on covariates
† parameter independent of covariates ‡ cumulative distribution function of latent variable 'x'
$\gamma(k, \frac{x}{\theta}) = \int_0^{\frac{x}{\theta}} t^{k-1} e^{-t} \mathrm{d}t$

the requirements (Song, 2000; Danaher and Smith, 2011) and therefore the function C can be written using a bivariate Gaussian copula as $C = \Phi_2(\Phi^{-1}(F_r), \Phi^{-1}(F_p); \rho_{rp})$ where Φ_2 is the bivariate standard normal distribution and ρ_{ep} is the correlation coefficient between e^* and p^*. ρ_{ep} ranges from -1 to $+1$ with the value of 0 indicating independence. When $\rho_{ep} = 0$, the copula function can be replaced by the product copula i.e. the product of the marginal univariate distributions. I estimate the model parameters by maximizing the joint-likelihood of equation 3.4 numerically using the general purpose OPTIM function in R statistical package. In order to estimate the dependence parameter of the copula function, I use a two-stage procedure (Trivedi and Zimmer, 2007). I first estimate the parameters associated with the three marginal distributions r^*, m^*, and P_p by assuming that r^* and P_p are independent and then subsequently estimate the dependence parameter in the second stage by rewriting the likelihood with parameters estimated using the first step. This is possible as the magnitude of the dependence parameter in a copula function does not affect the parameter estimates of the marginal distributions (See Trivedi and Zimmer (2007) and Joe (2005) for details of the two-stage procedure).

One can now create several variations of the this general framework by dropping one or two of the latent variables. For instance, if an explicit recommendation price is not set by the manager, one can drop r^* to create a special case. Additionally, the exact specification of the final model is based on the exact family of distributions selected for r^*, m^*, and P_p. A partial list of possible options based on the distributional assumptions used in previous literature is available in table 14. I use information theoretic criteria (AIC with penalty for over-parameterization (Akaike, 1974; Bozdogan, 1987))to determine the specification that provides the best fit.

In the following section, I use this simple yet flexible model to analyze a variety of PWYW payments including secondary and primary data. In addition to validating the proposed modeling framework, a major objective is to test my theoretical expectations of how different consumer groups respond to managerially controllable variables in a custom-designed PWYW setting.

3.4 Empirical Analysis

I use three different empirical approaches to test my hypotheses. First, I use a large secondary dataset containing PWYW payments for music licenses to validate my framework and provide a preliminary test of my expectations. I then confirm the findings using event analyses by taking advantage of firm initiated events that generate natural variations in the managerially controllable variables of interest. Additionally, I use two controlled experiments to collect primary data to further confirm my theoretical expectations. I adapt the modeling framework to include the customer participation decision in one of the experiments. The experimental studies address the limitations of the secondary data analysis together with confirming the results in different product contexts and different PWYW designs.

3.4.1 PWYW Payments for Music Licenses

Data. The data consists of a large sample of PWYW payments for music licenses paid to www.magnatune.com, an online record labels that works with independent musicians who produce original music within a wide variety of musical genre[19]. Magnatune provides a platform for musicians who are generally priced out of the main-stream market controlled by highly commercial record labels and enables them to reach a wide audience in exchange for a creative commons license[20] that buyers can avail of for any non-commercial ventures of their own such as background music for videoblogs and podcasts. The business model entails a 50/50 revenue sharing with the musicians and the website allows potential buyers to listen to the entire album before they decide to make a purchase. The company had used a PWYW pricing design to sell individual music albums until 2010 after which they moved to a monthly subscription model[21]. Consumers can freely listen to the entire album before they decide to purchase a download or a CD shipment that comes with a creative commons license. The musical artifacts are available in a variety of formats based on the needs of the customer.

The specific PWYW pricing design employed by this firm involved a minimum price ($5), a maximum price ($18), an explicit price recommendation ($8), and a menu of prices that included integer values between $5 and $18 with no option to

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[19]I thank Mr. John Buckman, a serial social entrepreneur who runs several online businesses in addition to Magnatune with the express interest of benefiting both artists and customers who are generally priced out of the conventional market, for sharing archived PWYW data for my analysis.

[20]'creative commons' is an alternative to the 'all rights reserved' copyright that retains some rights to the authors but provides as much flexibility to buyers for modifying, copying etc., within the confines of the license specification adopted. See https://creativecommons.org/ for more details.

[21]The fixed-fee subscription model was inline with the general shifting trend in online music from downloading to streaming for which a subscription fee was a better fit. As the marginal cost of reproduction was negligible, almost all of PYWY payments were profits for the firm

Table 15: Variable Definitions

Independent Variables/Covariates	Definition
download_i	1 if product is downloaded; 0 if shipped as CD
classical_i	1 if album is of classical genre; 0 otherwise
subscribe_i	Register with contacts to receive communication
album_purchase_freq	Cumulative album sales prior to purchase
artist_purchase_freq	Cumulative artist sales prior to purchase
first_purchase_i	1 if very first purchase by consumer; 0 otherwise
one_time_buyer_i	1 if purchased only once; 0 otherwise
weekend_i	1 if the day is saturday or suday; 0 otherwise

state a price point outside the menu options. The distribution of all payments in the sample is shown in Figure 3. Roughly 57% of the sample decided to pay the recommendation price, another 15% decided to pay the minimum legitimate price, and the rest of the sample paid a freely-chosen price using the price menu with the mode at $10. The overall mean PWYW payment was $8.08, a little more than the recommended payment.

Analysis. I used the general model described in the § 3.3 that includes only discrete prices without the option of a continuous price point — a special case that assumes the payment corresponding to the maximum price as indicative of consumer WTP lying anywhere between the maximum price and $+\infty$ — to analyze the dataset. Table 15 shows the definitions of the various independent variables/covariates. Most consumers purchased the licensed product only once. A small group of consumers that purchased more than once have purchased after widely varying intervals with some second purchases occurring more than a year after the first purchase. In order to differentiate the impact of a repeat purchase on prices, I included an indicator variable 'one_time_buyer_i' to distinguish one-time buyers from buyers who purchased more than once. Even though the mean cross-sectional payments over time remained fairly constant, I included time controls to account for time trend including an indicator

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variable to separate payments during the weekend from payments on other days. The key covariates of interest are the variables 'subscribe_i', 'album_purchase_freq_n', and 'artist_purchase_freq'. 'subscribe_i' serves as a proxy for relative anonymity[22] as it indicates consumer willingness to share personal information and allow firms to engage in a follow-up communication with them. 'album_purchase_freq_n' serves as a proxy for product quality information as it captures the normalized cumulative number of times a particular album had been downloaded/shipped prior to a purchase. Similarly, 'artist_purchase_freq_n' serves as a proxy for information on payment recipients as it captures the normalized cumulative number of times a particular artist's album had been downloaded prior to purchase. While it is harder to glean quality information from artist purchase frequency as it involves all albums by the same artist, both popular and unpopular, I believe it provides consumers with information on how well a certain artist or payment recipient had been compensated in the past. As consumers are likely to think about artist welfare in deciding their payments, new artists with no prior sales might elicit a larger payment. In table 16, I report the estimates of the proposed model and contrast it with the results of an OLS analysis of all payments combined together. The latter does not account for a heterogeneous response of different consumer sub-groups. The best fitting marginal distributions for the model specification was Normal, Normal, and Gamma for r^*, m^*, and P_p respectively.

Results.   The first and the second column of table 16 can be interpreted as the impact of the various covariates on the consumers' propensity to default to a

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[22]I acknowledge that this is not the same as total anonymity which I address in subsequent studies. It is hard to guarantee complete anonymity in an online payment setting where sellers are generally not privy to at least some personally identifiable information such as customers' credit card numbers. This is more a relative measure of anonymity.
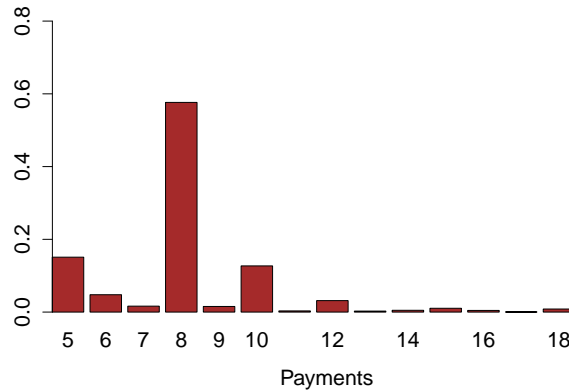
Distribution of PWYW Payments

Figure 3: PWYW Payments for Music License

recommendation price and their propensity to pay the least legitimate price respectively. The third column is the impact of various covariates on the magnitude of the freely-chosen price paid by consumers who neither paid a recommendation not the absolute minimum. The fourth column shows the results of OLS regression for the same set of covariates predicting the combined PWYW payments. The sign and significance of the parameters estimates for the three key variables of interest provide preliminary evidence for my theoretical expectations. I find that consumer propensity to default to a recommendation price increases as consumers have lesser relative anonymity i.e. when 'subscribe_i' is 0. In contrast, lower levels of anonymity decreases consumer tendency to pay the least legitimate price and also increases the magnitude of the freely-chosen PWYW payments. Similarly, I find that consumer propensity to default to a recommendation price or pay the minimum price decreases when information on album popularity indicates better product quality i.e. when 'album_purchase_freq_n' increases. I also find that consumer propensity to default to recommendation price or pay the minimum price increases when the previous artist purchase frequency increases. I believe that this provides some initial evidence that consumers adjust

	Proposed Model			OLS
	Recommendation (Normal)	Zeros (Normal)	PSP Magnitude (Gamma)	PSP Magnitude (Normal)
Variables	$\beta_{\mathbf{r}}$	$\beta_{\mathbf{z}}$	$\beta_{\mathbf{p}}$	$\beta_{\mathbf{p}}$
intercept	$+0.11\,(0.03)^{***}$	$-0.90\,(0.06)^{***}$	$+1.77\,(0.03)^{***}$	$+3.62\,(0.06)^{***}$
download_i	$-0.10\,(0.03)^{***}$	$+0.79\,(0.06)^{***}$	$-0.28\,(0.03)^{***}$	$-0.91\,(0.06)^{***}$
classical_i	$+0.13\,(0.02)^{***}$	$+0.11\,(0.03)^{***}$	$-0.02\,(0.02)^{*}$	$-0.12\,(0.03)^{***}$
subscribe_i	$+0.15\,(0.02)^{***}$	$-0.28\,(0.03)^{***}$	$+0.08\,(0.02)^{***}$	$-0.32\,(0.03)^{***}$
first_purchase_i	$+0.06\,(0.02)^{**}$	$-0.24\,(0.03)^{***}$	$+0.07\,(0.02)^{***}$	$+0.26\,(0.04)^{***}$
album_purchase_freq_n	$-0.02\,(0.01)^{*}$	$-0.09\,(0.02)^{***}$	$+0.00\,(0.01)$	$+0.07\,(0.02)^{***}$
artist_purchase_freq_n	$+0.12\,(0.02)^{**}$	$+0.12\,(0.02)^{***}$	$+0.01\,(0.01)$	$-0.08\,(0.02)^{***}$
one_time_buyer_i	$+0.04\,(0.04)$	$+0.04\,(0.04)$	$+0.06\,(0.02)^{**}$	$+0.05\,(0.04)$
weekend_i	$+0.05\,(0.03)$	$+0.05\,(0.03)^{*}$	$+0.01\,(0.02)$	$-0.00\,(0.03)$
t_month_seq	$+0.08\,(0.01)^{***}$	$+0.08\,(0.01)^{***}$	$-0.04\,(0.01)^{***}$	$-0.11\,(0.01)^{***}$
θ_p			$+2.50\,(0.04)$	
ρ_{ep}			$-0.00\,(0.01)$	

$^{***}p < 0.001$ $^{**}p < 0.01$ $^{*}p < 0.05$

$N = 24364$

their behavior based on information on recipients. They seem to compensate newer or less-compensated artists more than others. The impact of other covariates provide additional face validity to the proposed model. First time purchasers tend to pay more and have a greater propensity to default to a recommendation price while being less likely to pay the minimum price. CD shipments are valued more than album downloads as one would expect. It is important to note that the OLS regression that combines all payments without considering the various consumer groups is less informative and in some cases misleading. For instance, from the results one may conclude that loss of anonymity is detrimental as it decreases the overall mean PYWY payments.

Even though the results provide preliminary evidence for my theoretical expectations, I acknowledge that these are not definitive as the covariates are neither strictly exogenous nor a true realization of the constructs of interest such as anonymity,

payment recipient information and product value/quality. I seek to confirm these findings in subsequent empirical studies. However, it is clearly evident that design variations in PWYW pricing elicits a heterogeneous consumer response to changes in managerially controllable variables such as anonymity, information on product quality and payment recipients. Changes in these variables can result in either an increase or decrease in revenue depending on the magnitude of the recommendation price, the least legitimate price and the options available for consumers to pay a freely-chosen price based on their own evaluation.

3.4.2 Event Analyses

In order to provide additional support for my findings, I sought to identify if any promotional events from Magnatune created short-term variations in the constructs of interest when PWYW pricing design was operational. I probed the archives of the website's blog to identify two such events[23]. On Sep 01, 2005, the website had informed the potential buyers that their personal information will be shared with the musicians themselves. While the objective was to enhance the proximity between the payers and the payment recipients in hopes of positively influencing payments, it was soon reversed as it had a negative impact on revenue owing to loss of anonymity. This event can be considered a better measure of lack of anonymity. Similarly, on Sep 23, 2005, the website allowed the purchasers to share their albums/licenses with three other friends. This event allowed me to test if purchasers reciprocated the kind act (additional value not available otherwise) of the firm by adjusting their payments. I used a one week window before and after the event date to test for the impact on

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[23]I also confirmed with the author of firm's blog if the events pertain to variables of interest and inquired their motives behind the promotional offers

Table 17: Firm-initiated Events

Independent Variables	Definition
2005 SEP 01	Disclose purchaser information to musicians
2005 SEP 23	Rights to share product with three friends

Table 18: Event Analysis

Variables	Recommendation	Zeros	PSP Magnitude
anonymity	$-0.2064°$	-0.1148	-0.0137
added_value	$-0.1448°$	-0.1040	$+0.1745^*$

$^{***}p < 0.001$ $^{**}p < 0.01$ $^{*}p < 0.05$ $°p < 0.10$

payments after controlling for any weekend spike in sales. Table 18 shows the results of the simple before and after event analyses using the same tripartite model.

The results indicate that the loss of anonymity increased (marginal significance) the consumer propensity to default to a recommendation price . This is in line with what I found in the large sample secondary data analysis and provides additional support for the theoretical notion that consumers would prefer to default to available recommendation to avoid any threat to their self-image. Similarly, I find that consumers reciprocated the additional value provided by the firm by adjusting their payments. There is marginally significant reduction in the propensity to pay recommendation price but a significant increase the magnitude of freely-chosen PWYW payments. This finding provides additional evidence that consumers do not resort to paying a token price but rather take the value of the product into consideration while computing a fair payment.

In the following two sub-sections, I use controlled experiments with real PWYW payment to address a some outstanding issues that I'm unable to handle using

secondary data alone. First, I need to confirm that this is not simply a product specific phenomenon. It is possible to argue that music lovers are simply being prosocial to members of their own community. Second, what happens if the pricing design is altered to not include an explicit recommendation and also allow consumers to choose any continuous price point instead of discrete options. Will consumers seek for other references in the environment? Third, I'm unable to address customer decision to not participate in the exchange in response to the managerially controllable variables as I do not have access to consumer data from a secondary source. This could also potentially raise a selection issue in estimating PYWY payments. Fourth, what happens when recommendation price is altered by the manager. I address the first two concerns using a custom PWYW design for selling snacks in a laboratory environment for real payments. I address the latter two by selling college basketball tickets to students for real PWYW payments with different recommendation prices.

3.4.3 Snack Sale - Experimental Analysis I

Study Design. I invited student participants to evaluate a short film while consuming a snack in the behavioral lab of a large public university in the US. I used a PWYW design for the snack with no explicit recommendation including the option to pay nothing at all i.e. the minimum legitimate price is zero. Students were informed during the recruitment process that they would need to be in possession of at least $5 of their own money in cash in order to participate in the study although they may decide not to spend anything. 518 students participated in total. Each student received a prepackaged snack, roughly an ounce of chocolate & milk swirl chips before they watched the video for evaluation. I manipulated the visibility of PWYW payments (2 conditions; anonymous vs. public payments), timing of payments (2 conditions;

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at the time of receiving the packaged snack vs. post consumption at the end of the study), and information on payment recipients(2 conditions; local manufacturer vs. national brand) for a 2x2x2 design with students randomly assigned to one of the eight experimental conditions. Students in the public payment conditions made their payment to a lab assistant in public. They can both inquire and see what others are paying. I asked students in the private payment conditions to place their PWYW payments in an envelope containing no personally identifiable information and drop-off at a cordoned off location where no one else can identify their payments. All students filled out a follow-up survey that elicited their opinion on the video together with their assessment of the quality and their satisfaction with the snack. The intention of having the prepay and post-pay conditions was to test the impact of their personal valuation (through their satisfaction ratings) on their payments. Specifically, I looked for an interaction effect between post-pay and customer satisfaction on PWYW payments. Since customer satisfaction is endogenous i.e. prepaying consumers who paid more can also say they are more satisfied, I determine causal effect of customer value by checking for its interaction with post-paying consumers. In order to test whether information on payment recipients influence payments even when they are not related to charitable causes, I used the distinction between a national brand and a local manufacturer. I expected an increase in PWYW payments for local manufacturers drawing from the psychological theory of moral intensity discussed in § 3.2. Consumers are likely to feel an increased level of moral intensity as they decide on a fair-price for a local seller as opposed to an established national brand owing to the magnitude, likelihood, and proximity of impact. An image of the snack and the survey artifacts are available as part of the APPENDIX C.
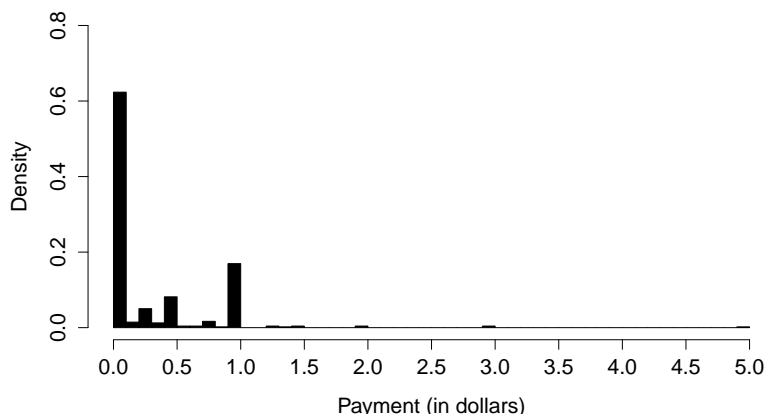
Distribution of Voluntary Payments

Figure 4: Payment Distribution for Snack Sale

Table 19: Snack Experiment - Results

Variables	Zeros (Normal)	Nonzero Payments (Weibull)
intercept	$+0.2897(0.1176)^{**}$	$-0.0302(0.0908)$
anonymity	$-0.1634(0.1184)^{\circ}$	$-0.2411(0.0909)^{**}$
post_pay	$-0.0399(0.0929)$	$+0.0229(0.1176)$
satisfaction_score†	$-0.2276(0.0906)^{**}$	$+0.0776(0.0750)$
satisfaction * post_pay	$-0.0042(0.1242)$	$+0.1783(0.1014)^{*}$
national_brand	$+0.1724(0.1177)^{\circ}$	$-0.1979(0.0923)^{*}$
θ_p		$1.6193(0.0866)^{***}$

$^{***}p < 0.001$ $^{**}p < 0.01$ $^{*}p < 0.05$ $^{\circ}p < 0.10$

† not an experimental condition

Analysis and Results. A total of 481 out of 518 PWYW payments were used for my analysis after removing the records of students who refused to consume the snack and those who correctly guessed the objective of the study. Fig 4 shows the distribution of payments in dollars. The overall mean payment was \$0.30 resulting in a 14% profit even though a little over 60% of the participants decided to pay nothing at all. As I do not have an explicit recommendation price in this PWYW design, I used a special case of the model in equation 3.2 without P_r and with P_m set to zero.

The model and its likelihood are available as part of the APPENDIX C. As a result, the model is a two process model with the first modeling the consumer propensity to pay nothing at all and the second modeling the magnitude of freely-chosen prices of those consumers who decided to pay a price. Table 19 shows the results of the parameter estimation. I once again find support for the three major theory based predictions. First, loss of payment anonymity increases the magnitude of non-zero payments. Fig 5 and 6 show the difference in distributions of non-zero payments for private and public payments. Even though no explicit price recommendation was provided, participants tended to pay $1 (a default to the mode of the distribution). This adds support to the notion that in the absence of an explicit reference price, participants in public condition used what others generally paid (a social norms based reference price) as an implicit recommendation. Descriptive norms defined as 'what most people tend to do in a given situation' have been found to have a significant impact on consumer decisions, both for private and public goods (Cialdini *et al.*, 1990; Schultz *et al.*, 2007; Goldstein *et al.*, 2008). Also, interestingly, in this particular case, the propensity to default to a $1 dollar had a positive effect on overall revenue as it shifted the distribution payments below a dollar in the private anonymous setting to the right in the public setting. Also, I'm unable to observe an increase in zero payments (marginal significance) when anonymity is lost. This is also in line with my findings from the secondary data analysis. Second, the interaction between post-pay condition and customer satisfaction is positive and significant. This confirms that consumers adjust their PWYW payments based on their value perception instead of simply paying a token price to preserve their self-image or alleviate post-exchange guilt of having been unfair. Third, participants paid significantly lesser for the snacks when they learned that the product was sold by large national brand as opposed

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Distribution of Private Payments
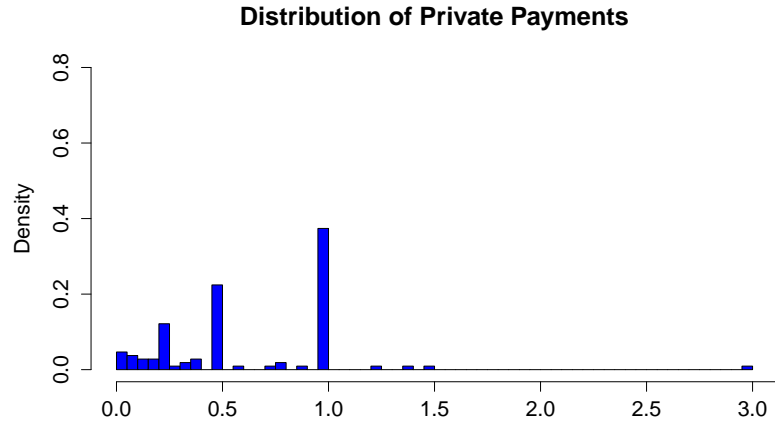
Figure 5: Payment Distribution for Snack Sale (Anonymous)

Distribution of Public Payments
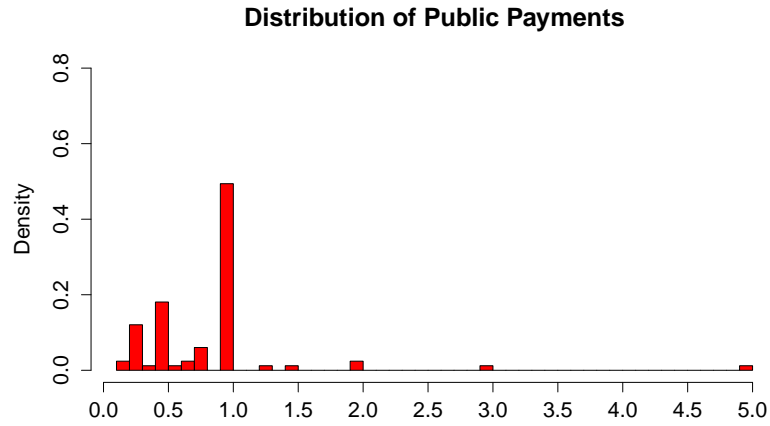

Figure 6: Payment Distribution for Snack Sale (Public)

to a local manufacturer. This is reflected in both the decrease in the magnitude of freely-chosen prices and the increase in the proportion of zero payments. The result indicates that information about payment recipients can significantly impact PWYW payments even they are not related to any explicit charitable cause.

3.4.4 Basketball Ticket Sale - Experimental Analysis II

Until now, I have not examined the customer participation decision in the context of the heterogeneous response of consumers to PWYW pricing design variations. This is important for two reasons. First, in response to changes in managerially controllable variables, some consumers might decide to opt-out of the exchange. For instance, when faced with public payments and a lack of reference price or a price recommendation they cannot afford, some might consider forfeiting the chance to receive the product for a PWYW payment of their choice. As firms frequently tend to use PWYW for market penetration as much as revenues, this is not a desirable outcome. Second, omitting the market participation decision can create a selection bias in the estimation of consumer WTP as the sample lacks information on the valuation of those who chose not to participate. This points to the importance of jointly estimating the market participation decision with the PWYW payments. I now describe a simple PWYW design for the sale of one or more college basketball tickets to address these concerns. Additionally, I manipulated the presence and absence of a price recommendation as an experimental condition to see how it influenced payments and participation decisions.

Study Design. I invited student participants to provide their opinion by answering a few questions on college sports for a chance to buy basketball tickets worth $10 for whatever price they wished to pay including nothing at all[24]. During the recruitment process I informed the participants that tickets will be exchanged as soon as payments are made. To accommodate lack of available cash for expenditures at the time of the experiment I let students reserve a ticket with a commitment to pay at the earliest. I
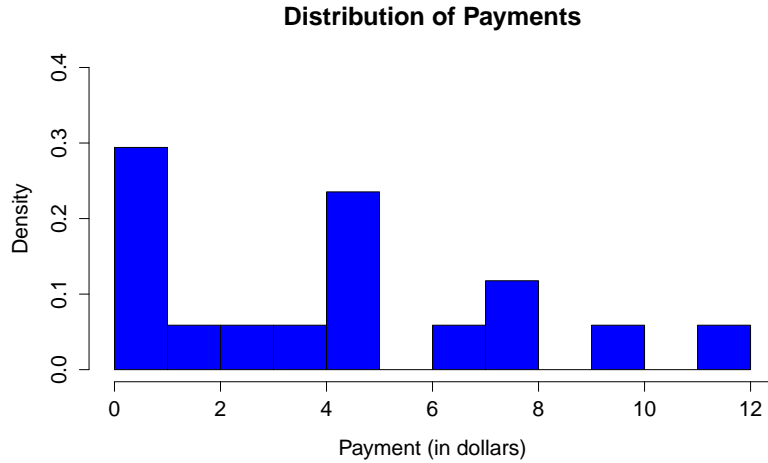
Distribution of Payments

Figure 7: Payment Distribution for Basketball Tickets

did not hand out the actual tickets until the payments were made[25]. However, if they indicated they wished to get tickets for no payment i.e. zero price which is acceptable in the specific design, I registered a PWYW payment of zero and let them have the tickets. I randomly assigned students to four conditions using a simple 2x2 design where I manipulated 2 levels for explicit price recommendations (no recommendations vs. a \$7 recommendation) and 2 different information on recipients (Student players vs. Basketball Coach). I intentionally chose a recommendation price lower than the face value of the ticket to encourage participation. A total of 332 students took part in the study but a mere 5.1% chose to participate in the PWYW exchange. Fig 7 shows the distribution of all payments with a mean value of \$4.38. In the following subsection, I briefly describe how I can adapt the proposed tripartite model of equation 3.2 to include the market participation decision.

Model. I introduce a latent variable x^* that captures the consumer propensity

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[25]I used only the completed transactions for my analysis as many students expressed a desire to buy yet failed to fulfill their payment obligation

to opt-out of the PWYW exchange such that when $x^* \leq 0$ one observes PWYW payments. If $x^* > 0$, the consumer decides to opt-out of the exchange i.e., no payment is observed. I assume that the consumer's valuation of a product is simply unknown allowing for the possibility of their holding a WTP (≥ 0) for the product under a different set of conditions. They simply decided not to participate. For instance, under lack of anonymity and an explicit recommendation price that is more than their WTP, some consumers might simply decide not to participate instead of making a payment lower than their WTP but still legitimate under a specific PWYW design. These consumers can be brought back to the market by reducing the recommendation price or by guaranteeing anonymity. Equation 3.5 specifies the model that includes the participation process.

$$
P = \begin{cases} -, & \text{if } x^* > 0 \quad \text{where } x^* \sim F_x(k_x, \theta_x); \quad \mathbb{E}[x^*|\mathbf{X_x}] = g_x(\mathbf{X_x}, \beta_\mathbf{x}) \\ 0, & \text{if } x^* \leq 0 \text{ and } m^* > 0 \quad \text{where } m^* \sim F_m(k_m, \theta_m); \quad \mathbb{E}[m^*|\mathbf{X_m}] = g_m(\mathbf{X_m}, \beta_\mathbf{m}) \\ P_p, & otherwise \quad \text{where } P_p \sim F_p(k_p, \theta_p); \quad \mathbb{E}[P_p|\mathbf{X_p}] = g_p(\mathbf{X_p}, \beta_\mathbf{p}) \end{cases} \tag{3.5}
$$

$$
\text{where } F_{xp}(\rho_{xp}) = \begin{cases} F_x \times F_p, & \text{if } \rho_{xp} = 0 \\ C(F_x, F_p; \rho_{xp}), & \text{otherwise.} \end{cases}
$$

Note that equation 3.5 appears very similar to equation 3.2 except that the dependence parameter ρ_{xp} now captures the dependence between the consumer participation process and the magnitude of payments. Although the structure is very similar, a significant ρ would indicate a sample-selection bias in estimating the magnitude of PWYW payments. Also, this model assumes no explicit price recommendation[26]. I have used the presence of recommendation price as an independent variable for this

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[26]Assuming an explicit recommendation will make this a four process model i.e. the decision to participate, decision to pay least legitimate price, decision to default to a recommendation, and the decision to pay a freely-chosen price.

particular experimental study. Also, I have retained the use of a copula function for joint estimation in order to preserve the flexibility to choose from a variety of distributions to fit PWYW payments[27].

Analysis and Results. Owing to the sample size of the participating consumer group being small, I pooled minimum payers and others who made a non-zero payment into a single group for analysis. Table 20 shows the results of the experimental analysis. A normal and lognormal specification provided the best fit for the participation decision and the magnitude of payments respectively. The bipartite model and its likelihood function are available along with the survey artifacts as part of the APPENDIX C. The second column of table 20 shows the impact of covariates on the consumer propensity to opt-out of the PYWY exchange while the third column shows the impact of covariates on the magnitude of the freely-chosen PWPW payments this time including the least legitimate price. Interestingly, the presence of an explicit recommendation had contrasting effects on the two dependent variables. While it negatively impacted the mean payment, it also simultaneously increased the consumer propensity to participate. Thus the loss of revenue owing to decrease in mean payments is counterbalanced by a potential increase in revenue owing to payments made by the new entrants. Indeed, total revenue per respondent with and without recommendation remained roughly equal ($0.46 and $0.42 respectively). This result can be explained by noting that the price recommendation was set lower than the face value of $10 per ticket reported during the initial description. Even as this brought down the

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[27]The specification can be thought of as a more general form of the specification used for models that account for sample-selection bias. See Smith (2003); Strazzera *et al.* (2003) for the use of copula approach to handle selection bias. This specification will reduce to a bivariate-normal sample-selection model if one uses the normal distribution assumption for both F_x and F_p, a Gaussian copula for C, and assume minimum payments as part of F_p distribution instead of accounting for them as a separate group of consumers.

Table 20: Ticket Experiment - Results

Variables	Opt-out (Normal)	Nonzero Payments (Lognormal)
intercept	$+3.5481(0.4643)^{***}$	$+4.300(1.5824)^{**}$
recc_price	$-1.0434(0.5139)^{*}$	$-4.3470(1.4851)^{**}$
recipient_coach	$-0.2152(0.5069)$	$-2.0243(1.4792)^{\circ}$
moral_intensity[†]	$+0.3150(0.2431)^{\circ}$	$+0.5772(0.5407)$
θ_p		$+2.3503(0.4972)^{***}$
ρ_{xp}		$-0.5310(0.1604)^{**}$

$^{***}p < 0.001$ $^{**}p < 0.01$ $^{*}p < 0.05$ $^{\circ}p < 0.10$

[†] not an experimental condition

magnitude of payments for participants in this condition, it encouraged participants to get the tickets. From a managerial standpoint, the results suggest that low price recommendations can still be profitable if a firms are able to attract more market participants. This is especially useful in cases where a crucial condition like anonymity cannot be guaranteed.

Additionally, when the payment recipients were portrayed as basketball coaches instead of players, I see a reduction in payments (marginal significance) confirming previous finding that consumers actively adjust their payments based on information pertaining to payment recipients. In the next section, I synthesize the findings of my empirical analyses to delineate takeaways for designers of PWYW pricing mechanisms, theoretical contributions that add to the knowledge of the emerging PWYW pricing literature, additional practical use of the proposed modeling framework, some important limitations, and direction for future research.

3.5   General Discussion

The recent popularity of the PWYW pricing mechanism, especially in the market for digital products, has resulted in academic investigations aimed at unearthing both the drivers of consumers' willingness to make non-zero payments and the drivers of success for businesses intending to employ this mechanism for profit. However, empirical investigations have largely neglected heterogeneity in consumer response to PWYW pricing especially with respect to both variations in managerially controllable contextual variables and the variations in PWYW designs employed in the market place. The major objective of this chapter was to investigate the heterogeneous consumer response to PWYW pricing designs in the context of three theoretically important and managerially controllable variables, namely, payment anonymity, product information that influence consumers' subjective valuation, and information on payment recipients. I specifically focused on three aspects of the consumer decision making process, namely, the consumer propensity to default to a recommendation price, propensity to pay the least legitimate price, and the magnitude of payment if it is a freely-chosen price. Also, in order to account for PWYW design variations, I developed a broadly applicable tripartite statistical model that accounts for the managerial design constraints such as the setting of price bounds (minimum/maximum prices), setting of an explicit price recommendation, and provision of a menu of discrete prices to choose from. Finally, I adapted the framework to account for customer participation decision and examined the impact of recommendations on customer participation and payments.

Theoretical Contribution. As PWYW pricing designs offer consumers the freedom to choose the payment of their choice, one might expect that consumers will tend to maximize their self-interest by choosing the least legitimate price. However, in line with previous findings in the literature, I find that a large proportion of consumers pay

a non-zero price. Even as consumers' prosocial preferences such as fairness concern and image concerns have been proposed as the primary drivers, the nature of these theoretical drivers dictate that payment anonymity, product quality information, and payment recipient information will have a major influence on consumer response. I provide three major theoretical insights on consumer response with respect to these variables.

First, when payment anonymity is not guaranteed, one might expect overall payments to either increase if consumers attempt to enhance their self-image by increasing the payments or decrease if consumers decide to opt-out of the PWYW exchange. In this research, I show that consumer response to anonymity is contingent on the explicit recommendation price set by managers. I find that consumer propensity to default to a recommendation price increases as anonymity is lost, even as the consumer propensity to pay the least legitimate price decreases. Paying the stated price recommendation alleviates both the uncertainty of arriving at a fair price and also any self-image/identity concerns consumers might have. As a consequence, the impact of anonymity on overall payments is dependent on the nature of the price recommendation. If is is set lower than the average consumer WTP in private settings, loss of anonymity can decrease payments. If the recommendation is higher than the average WTP in private settings, it has the potential to increase overall payments as more consumers choose to default to it. However, I also show that a lower recommendation can ensure increase in market participation by decreasing the consumer propensity to opt-out of the exchange. Therefore, any loss of overall revenue owing to a low price recommendation can be compensated by the entry of new market participants. Additionally, I provide evidence for consumer tendency to choose others' payments as a reference price in public settings whenever an explicit recommendation

is not available as part of the PWYW design. Second, consumers adjust their payments in response to variations in types of payment recipients. Consumers' notion of a fair-price can be influenced by what they learn about their recipients even when the sale is not tied to a non-profit setting or a charitable cause. This is in contrast to the product evaluation process in conventional pricing as consumers determine the fair-price for the product by evaluating the payment recipients together with the product itself. A mere difference in type of brand (national vs. local) can a have significant effect especially on the propensity to pay the least legitimate price. Third, consumers' personal valuation of the product based on their assessment of quality/satisfaction significantly alters their PWYW payments. This is in contrast to the notion that consumers tend to pay a non-zero price in PWYW settings primarily as a means to avoid self-image/identity concerns or the guilt of free-riding. In practice, many firms incorporate a PWYW design that require payments prior to product use especially in the online sale of digital goods. It is more beneficial to have consumers pay PWYW payments after product trial or consumption just as it is done frequently in service settings such as restaurants.

Managerial Contribution. The splitting of the market into different segments and an understanding of how their proportions are influenced by controllable variables allows managers to select a specific PWYW design that meets their objective given the constraints they face in a particular business context. For instance, where payment anonymity cannot be guaranteed, the fixing of an explicit recommendation price can be used to reduce the proportion of consumers that pay the least legitimate price. Similarly, information on payment recipients and a post-pay design can be used to enhance the moral intensity of PWYW payment, thereby enhancing revenues. Also, the exact levels of variables that make up a particular design can also be obtained by deriving objective functions using the general modeling framework and using a numerical optimization routine. For instance if the objective is to maximize revenue,

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one can choose the explicit recommendation price 'P_r', least legitimate price 'P_m', and a vector of levels of managerially controllable variables '$\mathbf{X}$' such that the total revenue is maximized. One can write the revenue maximizing objective function by using both equation 3.1 and equation 3.2 as

$$\underset{P_r, P_m, \mathbf{X}}{\text{maximize}} \; \Big\{ F_r(P_r, P_m, \mathbf{X}; \beta_{\mathbf{r}}) * P_r \; + $$
$$(1 - F_r(P_r, P_m, \mathbf{X}; \beta_{\mathbf{r}})) * (1 - F_m(P_r, P_m, \mathbf{X}; \beta_{\mathbf{m}})) * g_p(P_r, P_m, \mathbf{X}, \beta_{\mathbf{p}}) \Big\} \tag{3.6}$$

where β correspond to the estimated parameters and g_p correspond to the mean of all payments that are neither the minimum price or the recommendation price. It is important to note that market participation is omitted in the objective function. Those that opt-out of the exchange do not contribute to the revenue. However if the firm objective is to maximize market penetration, the objective is simply the proportion of consumers willing to participate in the exchange.

Limitations and Directions for Future Research. I acknowledge several important limitations that provide promising avenues for future research. First, I have limited myself to examining the impact of three managerially controllable variables. However, it is possible that several other contextual variables play a significant role in the heterogeneous consumer response to PWYW pricing designs. For instance, I do not examine how the presence of a fixed price competition to the same product will influence market participation in a PWYW exchange. Similarly, my empirical work has mostly examined a one-time interaction using cross-sectional analyses. PWYW payments can be significantly influenced by consumer decision to pursue a long-term relationship with the firm. Schmidt *et al.* (2014) report strategic self-interest where consumer desire to keep the firm using PWYW in business as an important driver of payments. Examining the heterogeneous consumer response to these contextual variables can yield managers insights into creating better PWYW designs. Second, I do not undertake the task of finding the optimal PWYW design for a certain business

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context even though I provide how the parameters estimated using the flexible model can be used for such a purpose. A more elaborate experimental design that varies recommendations, price bounds, etc., at different levels is required to calibrate the objective function introduced in the previous sub-section. I believe this will be a fruitful extension to this research.

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APPENDIX A

ESTIMATION PROCEDURE AND SIMULATIONS

Table 21: Parameters For Simulated Data

Latent Variable	Type	β	$\theta^{\star}$	$\rho_{ep}^{\dagger}$
e^*	Normal	$[-1 \quad 5]'$	$-$	$-$
v^*	Normal	$[-1 \quad 4.5]'$	$-$	$-$
p^*	Gamma	$[2 \quad -4 \quad 2]'$	5	0.45
	Weibull	$[2 \quad -4 \quad 2]'$	5	0.45

* independent shape parameter estimated from data

† dependence between e^* and p^*

A.1 Data Generation Process

The following list shows the steps required to simulate data that resemble the discrete outcomes of the IWTP elicitation procedure.

1. generate a vector of predictors $\mathbf{X_e}$, $\mathbf{X_v}$, and $\mathbf{X_p}$ for the dependent latent variables e^*, v^*, and p^*.

2. preset a vector of coefficients $\beta_{\mathbf{e}}$, $\beta_{\mathbf{v}}$, and $\beta_{\mathbf{p}}$ pertaining to each of the latent variables. These are parameters to be recovered from the simulation exercise.

3. generate the vector of link functions g_e, g_v, and g_p pertaining to each latent variable using predictors and the coefficients as shown in Table 2.

4. preset the independent parameters θ for each of the latent variables (for e^* and v^*, $\theta = 1$ for standard normal specification). The independent parameter (shape parameter) for p^* is to be recovered from the simulation exercise.

5. generate the vector of dependent parameters k pertaining to each latent variable using g and θ as shown in table 2.

6. generate the latent variables e^* and v^* using the inverse cumulative distribution function (in this case, inverse function of the standard normal) passing the

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corresponding k, θ and a vector of uniform random variables as arguments. e^* and v^* now follow F_e and F_v as shown in equations 2.3 and 2.4.

7. generate a vector of uniform random variables such that it is correlated with e^* by a preset magnitude ρ. This captures the dependence between e^* and p^*. ρ is to be recovered from the simulation exercise. For a Gaussian copula, given a uniform random u_1, a correlated random variable u_2 is given by $u_2 = \Phi(\Phi^{-1}(u1\rho) + v\sqrt{(1-\rho^2)})$, where v is a standard normal random variable. Φ is the standard normal distribution function and Φ^{-1} is its inverse.

8. generate the latent variable p^* using the inverse cumulative distribution function (for Gamma distribution, $F^{-1}(\theta, k) = \frac{1}{k^\theta \Gamma(\theta)} \int_0^u t^{\theta-1} e^{\frac{-t}{k}} \, dt$; and for Weibull distribution, $F^{-1}(k, \theta) = k(1 - \ln(1-u))^{\frac{1}{\theta}}$) passing the corresponding k, θ and a vector of uniform random variables (u) as arguments. p^* now follows F_p as shown in equation 2.4.

9. generate 3 sets of bids each with an initial (B_1), higher (B_H), and lower (B_L) bid by using an empirical quantile function that takes p^* and a percentage value as an argument. For instance, I use percentage values $\{0.25, 0.50, 0.75\}$, $\{0.27, 0.52, 0.75\}$, and $\{0.29, 0.54, 0.79\}$. Therefore, B_1 in the first bid set corresponds to the value of p^* such that the cumulative probability at $B1$ is 0.25.

10. create vectors of indicator variables I_e and I_p using the conditions specified in equations 2.3 and 2.4.

Table 21 shows the initial values chosen for the simulation exercise.

Table 22: Simulation Results

MODEL 1: $e^*, v^* \sim$ Normal; $p^* \sim$ Gamma				
Parameters	$N = 150$	$N = 250$	$N = 500$	$N = 1000$
$\beta_{\mathbf{e}}(\mathbf{1})$	$-1.0460(0.3010)$	$-1.0297(0.2296)$	$-1.0112(0.1582)$	$-1.0051(0.1112)$
$\beta_{\mathbf{e}}(\mathbf{2})$	$+5.2412(1.0082)$	$+5.1414(0.7386)$	$+5.0647(0.4963)$	$+5.0269(0.3471)$
$\beta_{\mathbf{v}}(\mathbf{1})$	$-1.0642(0.3368)$	$-1.0398(0.2510)$	$-1.0191(0.1752)$	$-1.0054(0.1196)$
$\beta_{\mathbf{v}}(\mathbf{2})$	$+4.7671(1.0020)$	$+4.6640(0.7328)$	$+4.5786(0.5016)$	$+4.5328(0.3378)$
$\beta_{\mathbf{p}}(\mathbf{1})$	$+2.0259(0.1756)$	$+2.0332(0.1319)$	$+2.0386(0.0933)$	$+2.0410(0.0647)$
$\beta_{\mathbf{p}}(\mathbf{2})$	$-4.0010(0.3180)$	$-4.0018(0.2435)$	$-4.0040(0.1725)$	$-4.0045(0.1202)$
$\beta_{\mathbf{p}}(\mathbf{3})$	$+2.0069(0.2723)$	$+2.0033(0.2073)$	$+2.0051(0.1472)$	$+2.0020(0.1048)$
θ	$+5.8928(1.8029)$	$+5.6122(1.2836)$	$+5.4072(0.8218)$	$+5.3363(0.5506)$
ρ_{ep}	$+0.4122(0.3674)$	$+0.4396(0.2635)$	$+0.4513(0.1774)$	$+0.4511(0.1224)$

MODEL 2: $e^*, v^* \sim$ Normal; $p^* \sim$ Weibull				
Parameters	$N = 150$	$N = 250$	$N = 500$	$N = 1000$
$\beta_{\mathbf{e}}(\mathbf{1})$	$-1.0543(0.3082)$	$-1.0349(0.2258)$	$-1.0139(0.1589)$	$-1.0083(0.1121)$
$\beta_{\mathbf{e}}(\mathbf{2})$	$+5.2591(1.0265)$	$+5.1543(0.7329)$	$+5.0676(0.5048)$	$+5.0365(0.3473)$
$\beta_{\mathbf{v}}(\mathbf{1})$	$-1.0776(0.3367)$	$-1.0372(0.2529)$	$-1.0194(0.1674)$	$-1.0044(0.1178)$
$\beta_{\mathbf{v}}(\mathbf{2})$	$+4.8047(1.0093)$	$+4.6612(0.7427)$	$+4.5761(0.4846)$	$+4.5300(0.3297)$
$\beta_{\mathbf{p}}(\mathbf{1})$	$+2.0088(0.1121)$	$+2.0148(0.0829)$	$+2.0210(0.0578)$	$+2.0214(0.0412)$
$\beta_{\mathbf{p}}(\mathbf{2})$	$-3.9939(0.2248)$	$-4.0013(0.1685)$	$-4.0051(0.1186)$	$-4.0000(0.0820)$
$\beta_{\mathbf{p}}(\mathbf{3})$	$+2.0006(0.1889)$	$+2.0029(0.1423)$	$+2.0049(0.0999)$	$+2.0002(0.0693)$
θ	$+5.9168(1.7799)$	$+5.5445(0.9475)$	$+5.3608(0.6016)$	$+5.3026(0.4008)$
ρ_{ep}	$+0.3965(0.4794)$	$+0.4169(0.3531)$	$+0.4482(0.2314)$	$+0.4514(0.1608)$

A.2 Estimation and Results

I minimize the negative logarithm of equation 2.7 by replacing F_e, F_v, and F_p with the respective cumulative distribution functions as specified in table 2. The copula function C_2 is the bivariate standard normal distribution function (Gaussian copula). I use MATLAB's *fmincon* function for numerical minimization with 'interior-point' method as the chosen algorithm. Both the independent shape parameter for p^* (θ) and the dependence parameter between e^* and p^* (ρ) are transformed to ensure an unconstrained optimization. Specifically, I use an exponential transformation and optimize for θ^* such that $\theta = e^{\theta^*}$. Similarly, I use a sigmoidal transformation for ρ by optimizing for a ρ^* such that $\rho = \frac{\rho^*}{\sqrt{1+\rho^{*2}}}$. I report the results of 4000 iterations for sample sizes $150, 250, 500$, and 1000 for both the Gamma and Weibull specifications for p^* in table 22. The estimates approach the true values as the sample size increases with decreasing variance. The estimates for the parameters are not sensitive to initial values and therefore can be arbitrarily set to 0 for a packaged version of the program.

APPENDIX B

CHAPTER 1 - SUPPLEMENTS

Product on Display for Study 1 (Laptop):

Product on Display for Study 2 (Flipflop):

Product on Display for Study 3 (Headphone):

Promotional material for new product with PAT (Study 1 - Laptop):

The following pictures show the same product you just evaluated except that *this product is remanufactured from a previously used product. [Remanufacturing by definition ensures quality that is identical to a new product and is required to be certified as such by the Environmental Protection Agency (EPA)].* This product is functionally identical to the previous product you evaluated with the same specifications and warranty. It is however a more environmentally sustainable alternative sold by the same firm. The computers and electronic equipment industry is a major source of hazardous solid wastes being accumulated in land fills. This product initiative is an attempt to reduce the environmental costs of waste by feeding them back into the manufacturing process wherever possible.

Promotional material for new product with PAT (Study 2 - Flipflop):

The following pictures show the same product you just evaluated except that *this*

product is made of materials recycled from previously used and returned flip flops and other rubber footwear. This product is otherwise identical to the previous product you evaluated with the same functional specifications, comfort and durability. It is however a more environmentally sustainable alternative sold by the same firm. Footwear is a major source of hazardous solid wastes being accumulated in land fills. This product initiative is an attempt to reduce the environmental costs of waste by feeding them back into the manufacturing process wherever possible.

Promotional material for new product with PAT (Study 3 - Headphone):

A new version of the product shown to you is being considered for introduction to the market. *The product will be made of recycled material (including plastic, fiber and metal) sourced from previously used and discarded products.* This is called *'Post Consumer Recycling'.* The new version of the product will be identical to the product on display here including functional specifications and warranty. It will however be a more environmentally friendly version. The computers and electronic equipment industry is a major source of hazardous solid wastes being accumulated in landfills. This new product initiative is an attempt to reduce the environmental costs of waste by feeding them back into the manufacturing process wherever possible.

Survey Questions:

Concern for environmental sustainability (7-point Likert scale).

1. Given an option, I would prefer environmentally sustainable products over regular products.

2. I derive satisfaction (utility) in buying environmentally sustainable products.

3. I'm indifferent to environmental sustainability when it comes to product purchase decisions *(reverse coded).*

Attribution of responsibility (7-point Likert scale).

1. I believe firms are responsible for any environmental harm resulting from production of products.

2. I believe firms must be made to pay for any environmental harm resulting from production of products.

3. I believe consumers are responsible for any environmental harm resulting from consumption of products.

4. I believe consumers must be made to pay for any environmental harm resulting from consumption of products.

Concerns about product quality and newness (7-point Likert scale).

1. I had quality concerns with the product that's made with materials from used products.

2. I was concerned about the "newness" of the product that's made with materials from used products

3. I have no problem assuming that the two products I evaluated today are of the same quality *(reverse coded).*

Consumer cost perception (dichotomous choice).

1. I believe that the product manufacturer incurs additional costs by remanufacturing from used products (1).

2. I believe that the product manufacturer saves costs by remanufacturing from used products (0).

Consumer trust (7-point likert scale).

1. I believe that the firm whose products I evaluated today acts in the best interests of the society.

2. I believe that the firm whose products I evaluated today makes truthful claims about its products.

3. I have doubts about the truthfulness of the claims made by the firm whose products I evaluated today *(reverse coded)*.

APPENDIX C

CHAPTER 2 - SUPPLEMENTS

EXPERIMENTAL ANALYSIS I (SNACK FOOD SALE)

Public pay instruction:

At this time, please make a payment to the lab assistant for the snack you received. Please let them know of your LAB ID. Remember, there is no fixed price for the snack. You can pay what you think the snack is worth (You can pay what you want for the snack including nothing). Whatever you pay will go to the snack supplier and is not retained in the lab.

Private pay instruction:

At this time, please make a payment using the plain unmarked envelope given to you, seal it, and leave it at your desk. Remember, there is no fixed price for the snack. You can pay what you think the snack is worth (You can pay what you want for the snack including nothing). Your payment is completely anonymous. Whatever you pay will go to the snack supplier and is not retained in the lab.

Payment recipient description:

The snack food made available to you today is a new candy from a local candy shop/large national brand. Please enjoy the candies as you watch the short film.

An ounce of snack:

Model used for analysis:

As no explicit recommendation price or a minimum positive price was set in this design, I use a bipartite model derived from the general model of equation 3.2 by excluding P_r and by setting the minimum price $P_m = 0$.

$$P = \begin{cases} 0, & \text{if } m^* > 0 \quad \text{where } m^* \sim F_m(k_m, \theta_m); \ \ \mathbb{E}[m^*|\mathbf{X_m}] = g_m(\mathbf{X_m}, \beta_\mathbf{m}) \\ P_p, & otherwise \quad \text{where } P_p \sim F_p(k_p, \theta_p); \ \ \mathbb{E}[P_p|\mathbf{X_p}] = g_p(\mathbf{X_p}, \beta_\mathbf{p}) \end{cases} \tag{C.1}$$

The likelihood of this model is given by

$$\mathcal{L}_p = \prod_0 \{1 - F_m(0)\} \quad \times \quad F_m(0) \prod_{P_p} \left[F_m(0) F_p(P_p^u) - F_m(0) F_p(P_p^l) \right]. \tag{C.2}$$

Note that this model has the same specification as a general linear model with zero inflation (Lambert, 1992). The model considers the participants who paid nothing and those who decided to make a non-zero payment as belonging to two distinct groups.

EXPERIMENTAL ANALYSIS II (TICKET SALE)

Payment recipient description:

(*Low moral intensity condition*) Revenues from college basketball ticket sale are used

to cover costs such as the wages and bonuses of highly paid coaches.

(*High moral intensity condition*) Revenues from college basketball ticket sale are very important to finance the scholarships of student athletes who otherwise would not have the opportunity to benefit from higher education.

PWYW sale description:

We now provide you with the opportunity to buy a ticket using a 'Pay What You Want' policy. This policy means that customers decide the amount they will pay. In other words, if you decide to buy the ticket to attend the game, you can freely choose the price you will pay for it including the decision to pay nothing at all. If you decide to buy a ticket please go to the lab assistant to collect it and make the payment of your choice. Then come back to answer a few more questions. If you decide to forgo the opportunity to buy a ticket, please proceed to the next section.

Moral intensity questions:

Consider a situation where a student like you is given the same opportunity to buy a PWYW ticket and decides to take it at a zero price (i.e., pays nothing at all for it). Please indicate the extent to which you agree or disagree with the following statements (5point agreement scale with 1 = strongly disagree; 5 = strongly agree)

1. The overall harm (if any) done as a result of this action would be very small
2. Most people would agree that this is wrong
3. There is a very small likelihood that this action would cause any arm
4. This action will harm very few people (if any)

Model used for analysis:

I use a bipartite model derived from the model that includes the participation process (see equation 3.5. As I did not observe inflation at zero payments, I combined all

payments and considered them as one segment. Those that decided not to participate (i.e. opt-out of the exchange) now belong to a different segment.

$$
\mathrm{P} =
\begin{cases}
-, & \text{if } x^* > 0 \quad \text{where } x^* \sim F_x(k_x, \theta_x); \ \ \mathbb{E}[x^*|\mathbf{X_x}] = g_x(\mathbf{X_x}, \beta_{\mathbf{x}}) \\
P_p, & otherwise \quad \text{where } P_p \sim F_p(k_p, \theta_p); \ \ \mathbb{E}[P_p|\mathbf{X_p}] = g_p(\mathbf{X_p}, \beta_{\mathbf{p}})
\end{cases}
$$

$$
\text{where } F_{xp}(\rho_{xp}) =
\begin{cases}
F_x \times F_p, & \text{if } \rho_{xp} = 0 \\
C(F_x, F_p; \rho_{xp}), & \text{otherwise.}
\end{cases}
\tag{C.3}
$$

The likelihood of this model is given by

$$
\mathcal{L}_p = \prod_{opt\_out} \{1 - F_x(0)\} \quad \times \quad F_x(0) \prod_{P_p} \left[C(F_m(0), F_p(P_p^u); \rho_{xp}) - C(F_m(0), F_p(P_p^l); \rho_{xp}) \right]. \tag{C.4}
$$

Note that this model has the same specification as sample selection model except that it uses a copula to account for a wide variety of distributions for payment. The significance of the dependence parameter ρ_{xp} signifies the presence of selection bias.