The Pay-What-You-Want Business Model: Warm Glow Revenues and Endogenous Price Discrimination

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Abstract

We explore the potential benefits of an up-and-coming business model called "pay-what-you-want" in an environment where consumers experience a warm glow by patronizing a particular firm. We show that, given a social norm regarding minimum contributions, a pay-what-you-want firm should announce a minimum suggested contribution, which is positive–but smaller than the profit-maximizing single price–so as to benefit from "endogenous price discrimination," whereby consumers differentially contribute more than the suggested minimum. Furthermore, a pay-what-you-want scheme can improve market efficiency and, in special cases, generate more profit than a standard posted price scheme. These results are robust to alternate motivations for generosity, including gift-exchange.

JEL Classification: L11, D42, D03, D64

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1 Introduction

Within the last year several news sources documented instances of an up-and-coming business model called "pay-what-you-want". The most publicized example occurred when Radiohead announced that their album *In Rainbows* could be downloaded at whatever price fans deemed reasonable. Restaurants, rental accommodations, and soccer clubs are also among those employing this business model. In fact, one

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pay-what-you-want (PWYW) Australian restaurant, Lentil as Anything, has expanded their enterprise from one to six locations since 2000 (Mantzaris, 2008). A recent and well publicized foray with the PWYW pricing scheme occurred when Panera Bread Company launched the "St. Louis Bread Company Cares Cafe" in Clayton, Missouri (Horovitz, 2010).[1] In a November 2010 press release, Panera announced the opening of a second PWYW restaurant in Dearborn, Michigan (and a planned opening in Portland, Oregon) claiming that "this expansion is the result of the concept's success in Clayton, Missouri" (Panera Cares, 2010).

In addition to these success stories, a series of three field experiments by Kim, Natter, and Spann (2009) found that consumers gave a positive amount when asked to pay what they want as compensation for eating at a lunch buffet at a Persian restaurant, watching a movie at a cinema, or drinking a hot beverage. Furthermore, PWYW generated significantly more revenue than a posted-price benchmark for the Persian restaurant, but less than the benchmark for the cinema. The success of PWYW in the Persian restaurant, and not the cinema, suggests that characteristics of the firm itself, and the way its clientele values those characteristics, are key factors to the profitability of PWYW.

While the PWYW pricing scheme will certainly not supplant more traditional pricing schemes, we will present a rational choice model to examine its viability that builds on a customer's distinct values over the firm's product and for the firm itself. Specifically, we will argue that, while the success of PWYW may vary from case to case, the PWYW firm is not destined to failure. Instead, we derive circumstances in which a PWYW firm can exceed the profits of a related, more traditional monopoly benchmark.

One approach to a PWYW firm[2] would literally be that a publicly available donation box would provide any customer with the legal right to claim one unit of a good, e.g. a cup of coffee, for any donation $x \geq 0$. If an individual's valuation of a cup of coffee consisted of the usual intrinsic valuation, v_i, then the degenerate result would occur that everyone with $v_i > 0$ would claim a cup of coffee for free. Our model is more sophisticated in two respects. First, we separate the intrinsic valuation for the product itself, v_i, from a "warm glow" from contributing positively to the firm.[3] There are at least three reasons why the dual value might be appropriate:

1. Group identity: Customers develop ties to the firm as part of their identity and thus the warm glow is derived from their purchasing of the product from that specific firm. While this notion is simple,

[1] The theory for this paper was written prior to Panera adopting this pricing scheme in Clayton, Missouri. In section 2, we formulate our theory based on a "minimum suggested contribution," while Panera primes customers by handing them a receipt with the dollar amount customers are charged at a more conventional Panera restaurant. Our presentation continues with a minimum suggested contribution, but we believe that the method used by Panera, as well as several others methods, are viable ways for pay-what-you-want firms to operationalize the opportunity for endogenous price discrimination, and the qualitative results we present are unchanged.

[2] We use the term "firm" broadly to apply to profit and not-for-profit corporations, individual proprietorships, partnerships, informal charities, and so forth.

[3] The term "warm glow" (popularized by Andreoni [1990]) suggests that consumers gain utility from the act of patronizing a particular firm. In our model, warm glow is obtained *only* by patronizing the firm and cannot be achieved by an isolated donation. The assumption that individuals' incentives to donate are tied to receiving something in return is supported empirically by Karlan and List (2008) and Falk (2007).

there is a growing consensus that identity and sense of self matter for economic decision-making. There are numerous situations in which normal theoretic exercises would yield different predictions if we did not consider identity (Akerlof and Kranton, 2000). In our case, it is clear that the success of some of these PWYW firms is outside the set of typical predictions. For example, the success of the Radiohead album has been attributed to how much the fans value the band itself (Ferguson, 2007). Therefore, the Radiohead success documents a phenomenon that is foreign to much of neoclassical economics: customers not only care about the benefit they receive from a good, but also that they are giving money to a firm (band, restaurant, sports club) with whom they identify.

2. Charitable support: The warm glow term could represent that customers have an additional value over related charitable activities of the firm. In a field experiment, Gneezy et al. (2010) report that Disney obtained the highest revenue in the Pay-What-You-Want pricing scheme when customers knew 50 percent of contributions would be donated to charity. Moreover, Panera Cares views their PWYW pricing a charitable act to those unable to afford higher prices.

3. Existence support: A forward-thinking consumer has a strategic incentive to support a PWYW firm in order to secure future benefits derived from the continued existence of the firm. This was shown formally by Fernandez and Nahata (2009), who use a dynamic model of interaction between consumers and a PWYW firm to show that PWYW can be a viable option. The payments in their model are based purely on self-interest, and therefore cannot be attributed to "warm glow" in the traditional sense. However, we believe that the future benefits of supporting the firm's existence, which are present in real world situations but not possible in our static model, can be reduced to a single benefit which the consumer enjoys immediately upon contributing, without altering any predictions of our model. Rather than model the selfish benefit as a separate component of the utility function, we will combine it with the rest of the "warm glow" incentives to contribute. Furthermore, some consumers may derive a direct psychological benefit from doing their part toward keeping a business afloat. In a threshold public goods experiment reported by Offerman et al. (1996), some subjects "acquire an extra utility of the act of contributing, but only if the public good is provided." (pg. 835) The continued existence of a PWYW firm is similar to a threshold public good and we expect some consumers experience a warm glow from helping achieve that goal. Finally, a consumer could benefit from the existence of a firm if they have direct preferences over the attributes of the owners (e.g. the "buy local" movement). Alchian (1950) argued that firms sometimes made decisions from a survivorship principle, that is, to earn enough money to proceed to the next period, and rational consumers must consider this when making a contribution.[4]

[4] The management of Calvin's Coffee Shop, a PWYW nonprofit entity in Tallahassee, Florida, placed a sign near their donation box which reads: "Like our coffee? Want us to stick around? ... Then please donate." This provides evidence that PWYW firms are attune to the fact that existence value motivates customers to donate

Secondly, we note that many PWYW pricing schemes adopt a "suggested donation." We believe that the existence of an explicit requested level of contribution suggests an in-place social norm for firms using PWYW.[5] Since our goal is to accurately model this institution, we will incorporate the underlying social norm that most[6] individuals will not claim a unit of the product without donating at least the amount suggested by the firm.

What is novel about our model is that it allows for customers to obtain a cup of coffee and rationally donate *more* than the suggested donation. Rational, heterogeneous customers will thus make a donation equal to or greater than the suggested donation of the firm. We call this phenomenon "endogenous price discrimination."[7] This differs from traditional first-degree price discrimination in that it does not depend upon the firm negotiating and extracting the maximum trading surplus from each customer on each unit. Rather, the task of the profit maximizing enterprise[8] is, somewhat akin to a single price monopolist, choosing a single parameter, in this case the minimal acceptable donation.

In Section 2 we formalize the model, including the nature of consumer preferences and the rational choice implications of these consumers operating in a world of a minimal acceptable contribution norm. Following that, we explore alternate profit maximization scenarios for the firms that take the rational decisions of warm glow consumers into account. We characterize the optimal minimum suggested donation and specifically compare it to a naïve benchmark in which a firm, not understanding the difference between customers' intrinsic and warm glow values, attempts to behave like a traditional single-price monopolist. In Section 3 we use specific market examples to demonstrate that 1.) a PWYW firm can earn more revenue and generate more efficient outcomes than a traditional firm, and 2.) a profit-maximizing PWYW firm should choose a suggested minimum donation which is below the monopoly benchmark price. In Section 4 we will model the inclusion of free-riders in the market and show that this may have a critical role in determining the profitability of a PWYW firm, even though many qualitative results of our model still hold. Finally, in Section 5 we briefly discuss some extensions such as a "gift exchange" motivation for the model.

2 A Theory of the Warm Glow of Patronization

In this section, we consider a scenario where a group of N consumers receive a warm glow from

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[5] There is empirical support for the idea that minimum contribution norms can develop based on explicit suggestion (Galbiati and Vertova, 2010) or information about the past contributions of others (Shang and Croson, 2005).

[6] For the purposes of analysis, we will assume that *all* individuals will adhere to the minimum contribution norm in Sections 2 and 3. We postpone the analysis of the inclusion of free-riders (those who consume the good without paying for it) until Section 4.

[7] Coffee shops commonly use other forms of price discrimination, such as nonlinear pricing (McManus, 2007), which we abstract away from in the model by having a single homogeneous good.

[8] Following Norton (2008) we posit that not-for-profit enterprises may nevertheless maximize retained earnings; they are simply prohibited from distributing those earning to shareholders.

patronizing a monopolistic seller. In other words, for a consumer, i, with an intrinsic value of $v_i \geq 0$ for the good in question, we add a "warm glow" value of $\alpha_i(\cdot)$ to the consumer's utility if she receives the good from this particular firm. However, common sense tells us that $\alpha_i(\cdot)$ is not fixed but depends on the amount of money contributed to the firm in relation to what might have been a reasonable expectation. In other words, a consumer must see her behavior as generous in order to receive the warm glow benefit. For simplicity, we assume that each consumer's utility is quasi-linear in money, which enables us to directly compare v and $\alpha_i(\cdot)$ to the money contributed to the firm. Specifically, consumer i's utility is given by

$$u_i(x) = \begin{cases} v_i + \alpha_i(\cdot) - x & \text{if the good is received} \\ 0 & \text{otherwise} \end{cases} \tag{1}$$

which implies that a consumer will donate and receive the good if and only if the total benefit ($v_i + \alpha_i(\cdot)$) exceeds the cost (x).

2.1 Definition of Warm Glow and Ideal Gift

In our model, we will assume that consumers experience a warm glow when their contribution to the PWYW firm is greater than what might be reasonably expected of them, either by themselves or others. We must therefore determine a reasonable expectation for how much a consumer would give to a PWYW firm. In our model, we adopt the commonly observed practice of PWYW firms using a "suggested donation" to the firm in exchange for one unit of the good. (In a later section, we will generalize this formulation.) We will call the suggested donation ρ, and ρ will generally serve as the level of contribution which consumers feel they are expected to give.[9] If this is the case, then the consumers receive a warm glow based only on the part of their contribution which is greater than ρ, because it is precisely this amount which they perceive to be beyond their expected donation.

There is, however, an important exception to the rule that ρ serves as the baseline donation beyond which a warm glow is received. When the consumer's intrinsic value of the good, v_i, is less than ρ, then the consumer is likely to feel differently about their contribution. Specifically, since the consumer is only willing to pay v_i for the good itself, any contribution to the firm in excess of v_i is seen as a "gift" to the firm, whether or not such a gift was expected. Regardless of the suggestions made by the firm and the corresponding norm created by those suggestions, a consumer of this type will receive a warm glow based on the part of their contribution which is greater than v_i, because the consumer would not have been willing to spend more than v_i for the good were they to buy it from another firm.

Although warm glow, $\alpha_i(\cdot)$, is in reality a function of x, v_i, and ρ, for descriptive purposes we can express warm glow as a function of one variable: the size of the perceived gift to the firm. Specifically, we

[9] For the remainder of this paper, we will refer to ρ as the firm's "suggested minimum contribution" in order to emphasize the fact that donations in excess of ρ are welcome. We believe that firms would, in practice, use language which indicates this fact to the consumers, rather than language which connotes a (suggested) posted price.

know that the amount $\min\{v_i, \rho\}$ is perceived as compensation for the good, and therefore anything contributed in excess of this amount can be defined as the gift to the firm, g, according to

$$g \equiv x - \min\{v_i, \rho\} \tag{2}$$

which allows the simplification of expressing warm glow as $\alpha_i(g)$ for $g \geq 0$. Our model further assumes that warm glow is a standard concave function with $\alpha(\cdot) \in \boldsymbol{C}^2$, $\alpha_i(0) = 0$, $\alpha_i' > 0$, $\alpha_i'' < 0$, and $\alpha_i'(\infty) = 0$.

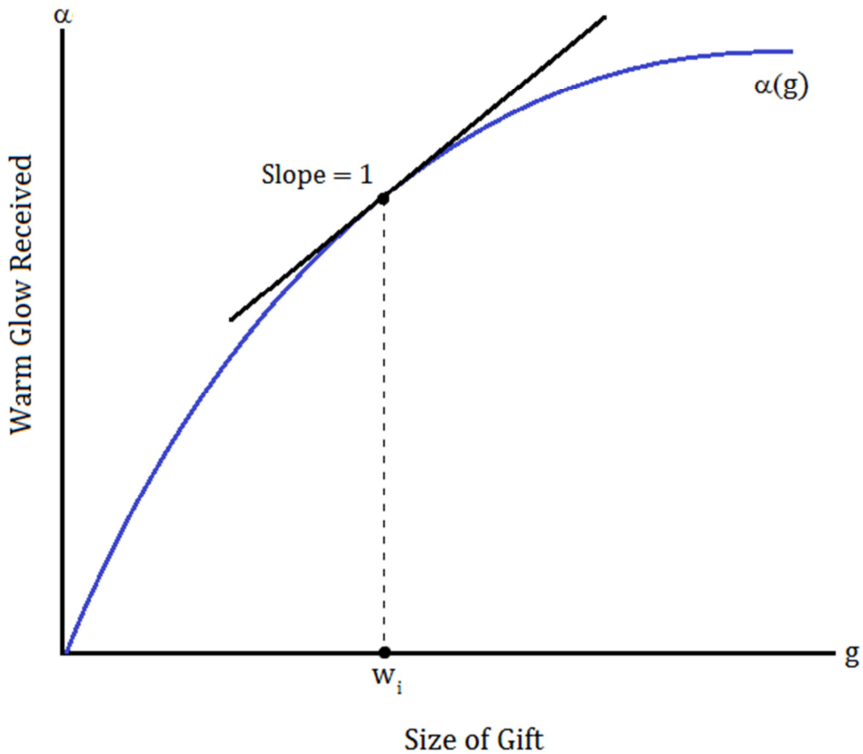

Figure 1: Warm Glow as a Function of Gift Size, and Ideal Gift, w_i

The utility gained from warm glow gives rational consumers an incentive to contribute more than the suggested minimum contribution of ρ, but not an unboundedly large amount because the marginal utility from warm glow necessarily decreases with donation size. Importantly, there is an **ideal gift**, or w_i, which we define to be the unique donation level where marginal utility of warm glow equals the marginal cost, or $\alpha_i'(w_i) = 1$ if such a value exists. If on the other hand a consumer never has $\alpha_i' \geq 1$, then this consumer is traditional in the sense that she would like to spend as little as possible to obtain the good and her ideal gift is defined to be 0.

2.2 Determining the Contributions of Consumers

Let z_i be consumer i's willingness to pay, or the largest amount the consumer would contribute to the firm. Then z_i must be the level of donation where the intrinsic value plus the warm glow exactly equals the donation, or

$$z_i = v_i + \alpha_i(z_i) \tag{3}$$

and there must be a unique solution to this equation due to the strict concavity of $\alpha_i(g)$. Henceforth, we assume the firm is aware of each consumer's willingness to pay, but at the same time it is not possible for the firm to use first-degree price discrimination to extract the entire surplus from the market because such technology is not feasible or appropriate. Instead the firm can make use of a pay-what-you-want strategy and choose a minimum suggested contribution, ρ, so as to benefit from the endogenous price discrimination of various consumers. In other words, the firm will choose a single parameter, ρ, and those consumers with $z_i \geq \rho$ will obtain the good while possibly contributing more than ρ, while those with $z_i < \rho$ will not obtain the good.

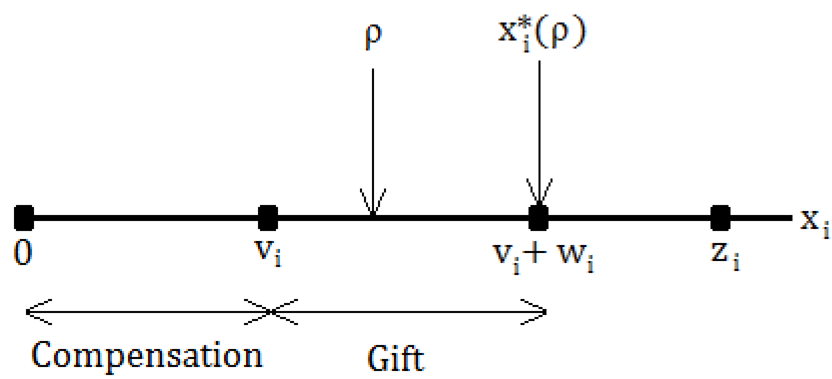

Figure 2: The Optimal Contribution Size, $x_i^*(\rho)$

Let $x_i^*(\rho)$ be the utility maximizing donation of consumer i. Due to the quasi-linear utility function in equation (1), it is straightforward to see that $x_i^*(\rho)$ is a piecewise linear function of ρ. Specifically, if the minimum suggested contribution is very low, the consumer gives ρ as compensation for the good, plus her ideal gift of w_i, as everything above ρ is perceived as a gift and by definition it is in her interest to give exactly w_i. If ρ climbs above the consumer's value, the consumer treats v_i as compensation for the good, because that is the most the consumer would have paid to a neutral firm, but still chooses an ideal gift of w_i in excess of her value (See Figure 2 for an example of this type of consumer). If ρ happens to be above $v_i + w_i$, the consumer does not want to give any more than ρ (part of which is seen as payment, and part which is seen as a gift), but she will still make a donation and obtain the good if her willingness to pay is greater than or equal to ρ. Finally, the consumer will not receive the good if ρ exceeds her willingness to pay. To summarize, a consumer's contribution is given by

$$x_i^*(\rho) = \begin{cases} \rho + w_i & \text{for} \quad 0 \leq \rho \leq v_i \\ v_i + w_i & \text{for} \quad v_i < \rho \leq v_i + w_i \\ \rho & \text{for} \quad v_i + w_i < \rho \leq z_i \\ 0 & \text{for} \quad z_i < \rho \end{cases} \tag{4}$$

where ρ is the suggested minimum donation, v_i is the intrinsic value, w_i is the ideal gift, and z_i is the willingness to pay for the good.

2.3 Comparison of Benchmark Price to Optimal Suggested Minimum

We now consider the actions of a standard profit-maximizing firm who is given perfect information about each consumer's willingness to pay, z_i. Note that this willingness to pay *already includes* the warm glow benefits to the consumers for purchasing from this particular firm, as described in equation 3. For simplicity, we assume the firm is a monopolist which can produce at marginal cost, c, with zero fixed costs. Suppose the firm hired an economist who was given only the schedule of z_i's and who misinterpreted them as standard willingness to pay valuations. That is, the advisor, unaware of the potential benefits of endogenous price discrimination, would look for the *prima facie* profit-maximizing single posted price of the good, which we refer to as the monopolist's benchmark price.

Definition 1 *The* ***benchmark price*** *of a monopolist with marginal cost, c, facing* N *consumers with willingness to pay of* $\{z_i\}_{i=1}^N$ *is equal to* p^* *where*

$$p^* = \arg\max_p \{(p-c)q(p)\}$$

where $q(p) = |\{z_i : z_i \geq \rho\}|$*, or the number of consumers whose willingness to pay is greater than or equal to the price,* p*.*

The value of the benchmark price, p^*, is the same whether we interpret it as the profit-maximizing price for a posted-price firm, or the suggested minimum contribution in a PWYW firm who does not make a distinction between the consumer's two different sources of utility. In either case, some consumers may contribute more than the benchmark price (possibly using a tip jar) if it is in their interest to do so.

A sophisticated monopolist, however, is concerned with maximizing the sum of both sources of revenue, compensation and gifts. If a PWYW firm knows how much of each consumer's demand comes from intrinsic value for the good and how much is due to the warm glow of generosity, it can predict the contributions of each consumer and find the suggested minimum contribution which will generate the most profit.

Definition 2 *The* ***optimal suggested minimum contribution*** *of a monopolist with marginal cost, c, facing* N *consumers with valuations of* $\{v_i\}_{i=1}^N\}$*, ideal gifts of* $\{w_i\}_{i=1}^N$*, and willingness to pay of* $\{z_i\}_{i=1}^N$ *is* *equal to* ρ^* *where*

$$\rho^* = \arg\max_{\rho}\left\{\sum_{i=1}^{N} x_i^*(\rho) - q(\rho) * c\right\}$$

where $x_i^*(\rho)$ *is defined to be consumer* i*'s contribution given the suggested minimum contribution of* ρ *as determined by 4.*

We will assume that ρ^* and p^* are chosen to be the smallest values which serve as their respective maxima. The following two lemmas will be useful for comparing the benchmark price and optimal suggested minimum.

Lemma 1 *The benchmark price,* p^**, and the optimal suggested minimum contribution,* ρ^**, must each be equal to* z_i *for some* i*.*

The intuition behind Lemma 1 is the well-known fact that when facing discrete willingness to pay steps on a downward sloping demand curve, a firm would never choose a price between the steps. Because of this lemma we need only compare the firm's outcome given a suggested minimum chosen from the set of all z_i, which we have assumed is common knowledge. Without loss of generality, we can re-index the consumers such that

$$z_1 \geq z_2 \geq \cdots \geq z_N$$

which implies that the suggested minimum which will result in the sale of i units is simply z_i. We can now define marginal revenue, $MR(i)$, as

$$MR(i) = R(i) - R(i-1) \text{ for all } i = 1, \dots, N$$

where $R(i)$ is defined to be the total contributions gained from selling i units of the good at a suggested minimum of z_i. Any units which may have been purchased by equally willing to pay consumers, indexed by $j > i$, are assumed to go unsold. Similarly, we now define marginal benchmark revenue, $MBR(i)$, as

$$MBR(i) = iz_i - (i-1)z_{i-1}$$

which is the additional revenue gained under the benchmark assumption that each consumer pays only the price of the good.

Lemma 2 *The marginal revenue of selling the* i*-th unit,* $MR(i)$*, is greater than or equal to the marginal benchmark revenue of selling the* i*-th unit,* $MBR(i)$*.*

Proof. Having sold $i-1$ units, the suggested minimum must be decreased to z_i in order to sell the i-th unit, and the added revenue from consumer i is thus z_i. This is also the added revenue from consumer i under the benchmark assumption. Now consider the revenue lost from consumers 1, 2, ..., $i-1$ due to a decrease in the suggested minimum from z_{i-1} to z_i. Under the benchmark assumption, the revenue lost from each consumer is exactly $z_{i-1} - z_i$. However, knowing the contribution level, $x^*(p)$, given in 4, we can see that

$$\frac{d}{d\rho} x_i^*(\rho) = \begin{cases} 1 & \text{for} \quad 0 < \rho < v_i \\ 0 & \text{for} \quad v_i < \rho < v_i + w_i \\ 1 & \text{for} \quad v_i + w_i < \rho < z_i \\ 0 & \text{for} \quad z_i < \rho \end{cases} \tag{5}$$

which means that as price decreases, the first i - 1 consumers' contribution decreases as a rate less than or equal to the rate at which price decreases, which means that the revenue lost from each consumer is less than or equal to the magnitude of the price decrease, or z_{i-1} - z_i. Therefore MR(i) ≥ MBR(i) as desired.

Equation 5 shows that a consumer's contribution may not be responsive to changes in the minimum suggested contribution. If ρ is chosen to be anywhere between a consumer's intrinsic value, v_i, and the sum of her value and ideal gift, $v_i + w_i$, then that consumer's contribution is fixed at $v_i + w_i$. The existence of this type of consumer (see Figure 2 for an example) will be a catalyst for the sophisticated monopolist to lower its suggested minimum contribution, allowing infra-marginal consumers to obtain and pay for the good, while maintaining a high revenue from some of the supra-marginal consumers.

Proposition 1 *Given a monopolistic seller with marginal cost, c, facing N consumers, each with 1.) an intrinsic value for consuming one unit of a good, v_i, 2.) an increasing and concave warm glow from giving to this monopolist, and 3.) a strict adherence to a norm whereby no consumer receives the good unless they have contributed the suggested minimum, the optimal suggested minimum contribution in a pay-what-you-want business model is less than or equal to the benchmark posted price for the monopolist.*

Proof. By Lemma 1, $p^* = z_j$ for some j, and $\rho^* = z_k$ for some k, where j and k represent the number of units sold under each suggested minimum contribution decision. Assume that, contrary to the proposition, the optimal suggested minimum, ρ^*, is greater than the benchmark price, p^*. This means that $k < j$, because fewer units must be sold under the optimal suggest minimum. However, because p^* maximizes profits under the benchmark assumption, it must be the case that increasing the number of units sold from k to j increases benchmark revenue by at least the cost of those units. In other words, we know

$$\sum_{i=k+1}^{j} MBR(i) \geq c(j-k)$$

However, by Lemma 2 we know that $MR(i) \geq MBR(i)$, which implies

$$\sum_{i=k+1}^{j} MR(i) \geq \sum_{i=k+1}^{j} MBR(i) \geq c(j-k)$$

which means that profit weakly increases by increasing the number of units sold from k to j, which means that no value of ρ greater than p^* could have been the optimal suggested minimum, since setting $\rho = p^*$

would dominate it, given that the monopolist chooses the lowest suggested minimum when indifferent.

The intuition behind Proposition 1 is the following. When a firm has the luxury of choosing a lower bound to the amount of money that consumers will contribute in exchange for a good, they have an incentive to set the lower bound below the posted-price benchmark, because they will sell more units this way. In the pay-what-you-want scheme, there may be some consumers who still contribute as much as they would have at the posted-price benchmark due to their endogenous price discrimination. One might argue that this intuition suggests that the optimal suggested minimum should go all the way down to zero, but that is not the case. Our model assumes that consumers distinguish between gifts to the firm and compensation for the good, and a suggested minimum of zero implies that no money is necessary as compensation for the good, perhaps because the firm is not "asking" for anything to compensate them for the good. While setting $\rho = 0$ would mean that each consumer contributes the full value of w_i to the firm, the increased contributions in the form of gifts would not in general compensate for the loss of revenue in the form of compensation. It is therefore a non-trivial exercise to determine ρ [10].

2.4 Welfare Implications of Pay-What-You-Want Scheme

This section formalizes the welfare implications of a pay-what-you-want scheme. Any consumer who values the good more than its marginal cost but does not receive it adds to the deadweight loss in the market. Therefore, by increasing the number of consumers who receive the good, the PWYW scheme has the potential to increase efficiency, profit for the firm, and flexibility for the consumer. If a posted price leads consumers to collapse their contribution to the posted price, we have the following corollary of Proposition 1.

Corollary 1 *Given a monopolistic seller and N consumers as described in Proposition 1, if there is at least one consumer who would like to contribute more than the profit-maximizing benchmark price, p^*, then a pay-what-you-want pricing strategy is a Pareto improvement over a single posted price strategy.*

Proof. Because ρ^* is the optimal suggested minimum given a PWYW strategy, the firm weakly prefers to let $\rho = \rho^*$ over setting $\rho = p^*$ given this strategy. However, they strictly prefer the PWYW strategy with $\rho = p^*$ to the single posted price of p^* because of the one consumer choosing to give more. Because $\rho^* \leq p^*$, each consumer can choose to pay p if they like, thus each consumer's choice under the PWYW strategy is weakly preferred to the single posted price strategy.

[10] In fact, for sufficiently small v_i's, ρ^*=0, as the incentive to keep ρ above zero diminishes because each consumer's contribution is entirely a gift. However, for sufficiently small w_i's, $\rho^* = p^*$, as the firm's decision becomes increasingly identical to a traditional profit-maximizing monopolist as the gift-giving motive disappears. In general, $\rho^* \in [0, p^*]$.

2.5 Continuous Demand Case

In the previous sections we consider a finite number of consumers, which results in a finite number of possibilities for p^* and ρ^*, due to the result of Lemma 1. Therefore, there are discrete jumps in the pricing decisions of the monopolist, and it may be the case that $p^* = \rho^*$ simply because both prices fall into the same discrete jump. To eliminate this possibility, we alter the model so that there is a continuum of consumers, indexed by $i \in [0, 1]$. Furthermore, we will assume the demand curve determined from consumers' willingness to pay is differentiable at the price, p^*. In this version of the model, using the same intuition as before, we can prove the following stronger result.

Proposition 2 *Given a monopolistic seller with marginal cost, c, and a continuum of consumers with properties 1-3 of Proposition 1, the optimal suggested minimum contribution, ρ^*, is strictly less than the profit-maximizing single posted price, p^*, if the demand curve is differentiable at p^* and there is a positive (Lebesgue) measure of consumers with the following property: $v_i \leq p^* < v_i + w_i$.*

Proof. Let $A \subseteq [0, 1]$ be defined such that $i \in A$ if and only if $z_i \geq p^*$. Let $B \subseteq [0, 1]$ be defined such that $i \in B$ if and only if $v_i \leq p^* < v_i + w_i$. Note that $B \subseteq A$, because $p^* < v_i + w_i$ implies that $z_i \geq p^*$. By the assumptions of the proposition, $\mu(A) \geq \mu(B) > 0$, where $\mu(.)$ is the standard Lebesgue measure. Because demand is differentiable at p^*, we know that marginal (benchmark) revenue is continuous at p^*, and because this is the profit maximizing single price, it must be c. Benchmark revenue is equal to $p^* * \mu(A)$, and letting a be the absolute value of the slope of the demand curve at p^*, we have the formula for marginal benchmark revenue at p^* of

$$MBR(p^*) = p^* - \mu(A) * a = c$$

If the firm is concerned with actual marginal revenue, it will find that only $\big(\mu(A) - \mu(B)\big) * a$ is lost due to the decrease in price because those consumers who belong to B will not change their actual contributions to the firm due to an infinitesimal decrease in the suggested minimum. Therefore

$$MR(p^*) = p^* - \big(\mu(A) - \mu(B)\big) * a$$

$$MR(p^*) > p^* - \mu(A) * a = c$$

which shows that the true marginal revenue of a decrease in the suggested minimum contribution is greater than the marginal cost at p^*, which implies that the firm should increase the quantity sold by choosing ρ strictly less than p^* as desired.

As in the discrete case, when a PWYW scheme is used, the monopolist has an incentive to include more consumers in the market, which results in greater efficiency and, typically, a Pareto improvement.

3 Examples of Markets with Known Demand

For illustrative purposes, we provide in this section two natural market examples where a PWYW scheme results in higher revenue for the seller and higher economic efficiency relative to a single posted price scheme. Furthermore, these examples will demonstrate that a firm using the PWYW scheme while using the monopolist benchmark price as ρ can do strictly better by reducing the suggested minimum to the true optimal suggested minimum, ρ^*.

3.1 Example 1: Warm Glow Aligned With Value

In our first example, those consumers with the highest valuations for a particular good also have the strongest warm glow. Consider a monopolist who faces demand from $N = 10$ consumers (with an adherence to the suggested minimum norm), a marginal cost c, with intrinsic and warm glow values given by:

i	v_i	w_i	z_i
1	45	45	135
2	40	40	120
3	35	35	105
4	30	30	90
5	25	25	75
6	20	20	60
7	15	15	45
8	10	10	30
9	5	5	15
10	0	0	0

Quantity	"Price"	Quantity*Price	PWYW Contributions
1	135	135	135
2	120	240	240
3	105	315	315
4	90	360	360
5	75	375	395
6	60	360	420
7	45	315	440
8	30	240	420
9	15	135	350
10	0	0	225

In this example, ideal gifts are equal to intrinsic valuations, both of which are a linear step function. Willingness to pay, z_i, is equal to $v_i + 2w_i$, which corresponds to the warm glow function depicted in Figure 1. Due to Lemma 1, both a traditional single-price firm and a PWYW firm need only consider setting a price (or suggested minimum) at the 10 values of z_i, which is equivalent to choosing the quantity of goods to sell. If $c = 10$, a traditional monopolist would choose $q = 5,\ p = 75$, because marginal revenue exceeds marginal cost up to this point. However, if a PWYW firm were to set a suggested minimum contribution of 75, there would be two consumers who meet the criteria given at the end of Proposition 2 and have contributions similar to the consumer described in Figure 2. By reducing the suggested minimum to $\rho^* = 45$, the firm sells to two infra-marginal consumers while keeping contributions unchanged for these two highest-value consumers. The additional revenue of 45 exceeds the additional costs of 20. Therefore, if $c = 10$, a PWYW firm has an incentive to lower the suggested minimum below the price that an economist would claim is profit maximizing having seen only the willingness to pay of the consumers in the market. Furthermore, the addition of two otherwise infra-marginal consumers enhances efficiency by reducing the deadweight loss of the market.

Figure 3: Profits of the Monopolist in Example 1, with Marginal Cost = 10

The result that adding infra-marginal consumers increases profits for a PWYW firm is not universally true. In particular, if we consider Example 1 again with a higher marginal cost, $c = 40$, the gains from adding infra-marginal consumers are destroyed by the additional costs, and in Figure 4 we show that a PWYW firm would choose the same quantity as a posted-price firm, and there are no benefits from using PWYW even in the case where there are no free riding consumers and everyone contributes the minimum suggested amount. This example makes it clear that there is a critical level of marginal costs of production, in this case $c = 35$, above which a firm should be advised against using PWYW.

Figure 4: Profits of the Monopolist in Example 1, with Marginal Cost = 40

3.2 Example 2: Warm Glow Inversely Related to Value

In our previous example, ideal gifts were assumed to be equal to consumers' intrinsic values for the good, while in general, a person's desire to contribute to a particular firm might not be (positively) correlated with their desire for a particular good. In this example, we keep intrinsic values the same, but assume that ideal gifts are inversely related to value and every other consumer has no warm glow at all:

i	v_i	w_i	z_i
1	45	0	45
2	40	10	60
3	35	0	35
4	30	20	70
5	25	0	25
6	20	30	80
7	15	0	15
8	10	40	90
9	5	0	5
10	0	50	100

Quantity	"Price"	Quantity*Price	PWYW Contributions
1	100	100	100
2	90	180	180
3	80	240	240
4	70	280	280
5	60	300	300
6	45	270	295
7	35	245	315
8	25	200	305
9	15	135	265
10	5	50	195

Figure 5: Profits of the Monopolist in Example 2, with Marginal Cost = 10

Once again, there are 10 unique values of z_i, so in both payment schemes, the firm's decision rests on determining the optimal number of units to sell. Given the price-quantity pairs from which to choose, the traditional monopolist would choose a price of $p = 60$ if marginal cost $c = 10$. If a PWYW firm reduces its minimum suggested contribution to $\rho^* = 35$, it can benefit from the addition of two consumers ($i = 1$, 3) for an added revenue of 70, while still receiving a contribution of 50 from 4 of the consumers ($i = 4$, 6, 8, 10) who would have contributed 60 if the suggested minimum contribution were 60 (for a revenue loss of 40) and a contribution of 45 from the consumer with index $i = 2$ (for a revenue loss of 15). Therefore, total revenue is $300 + 70 - 55 = 315$ at $\rho = 35$, which represents an increase of revenue of 15 over the benchmark optimal price by selling two additional units. However, Figure 5 shows that this marginal increase in revenue would not be profitable if $c = 10$, and only when $c < \frac{15}{2}$ would the PWYW firm take advantage of the endogenous price discrimination which occurs with a reduced suggested minimum contribution.

4 Addition of Free-Riders to the Model

In this section we will discuss the implications of the addition of free-riders to the model. We will show that while the presence of free-riders could have drastic implications concerning the profitability of the PWYW pricing scheme, if the firm is using PWYW, the optimal suggested minimum is still less than the benchmark monopoly price if demand is continuous and free-riding is uncorrelated with demand.

4.1 Continuous Demand Case

As in Section 2.5, we consider a continuum of consumers, indexed by $i \in [0, 1]$, with valuations v_i and ideal gifts w_i. In order to update the model with the inclusion of free-riders, we will say that each consumer is independently determined to be a free-rider with probability λ. The set of free riders has a measure of λ and the set of remaining consumers has a measure of $1 - \lambda$ with probability one[11]. We define a **free-rider** to be a consumer who will always take one unit of the good without contributing anything to a PWYW firm[12]. Of course, a traditional posted-price firm can still earn revenue from free-riders, as they will purchase the good if their willingness to pay is greater than or equal to the posted price.

Proposition 3 *Given a monopolistic seller with marginal cost c and consumers indexed* $i \in$ *[0, 1] with intrinsic values* v_i*, ideal gifts* w_i*, each of whom is a free-rider with probability* $\lambda \in$ *(0, 1), the optimal suggested minimum contribution,* ρ^**, is strictly less than the profit-maximizing single posted price,* p^**, if the demand curve is differentiable at* p^* *and there is a positive (Lebesgue) measure of consumers with the following property:* $v_i \leq p^* < v_i + w_i$*.*

Proof. We will show, as before, that the marginal revenue of the firm at p^* is greater than c. Let $L \subset [0, 1]$ be the set such that $i \in L$ if and only if consumer i is not a free-rider. Let A be the subset of [0, 1] such that $i \in A$ if and only if $z_i \geq p$. Let $A' = A \cap L$. By the law of large numbers, $\mu(A') = (1 - \lambda) * \mu(A)$. Letting a be the absolute value of the slope of the demand curve (including free riders) at p^*, the marginal revenue of a traditional posted price firm at p is once again

$$MBR(p^*) = p^* - \mu(A) * a = c$$

Now consider the demand from only those consumers in the set L. Since total demand is differentiable at p^*, and the set of consumers who belong to L are uniformly dense in the entire set of consumers, the function $Q(p) = |\{i \in L : z_i > p\}|$ must also be differentiable at p^* . By the law of large numbers, $\frac{dp}{dQ}$ evaluated at p^* is equal to $\frac{a}{1-\lambda}$, because for a given increase in price, there need to be $(1 - \lambda)$ times as many consumers dropping out of L as compared to the original set. The marginal benchmark revenue from consumers in L at p^* is equal to $MRP'(p^*)$ where

$$MBR'(p^*) = p^* - \mu(A') * \frac{a}{1 - \lambda}$$

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[11] This fact is due to Uhlig (1996) who showed that the law of large numbers can be applied to a continuum of IID random variables so long as the Riemann sum converges in mean-square to the desired value as the maximum partition of the Riemann sum goes to zero. Applied to our model, the nth Riemann sum, R(n) is the fraction of free-riders in a sample of size n, where the random variable nR(n) has the binomial distribution, B(n, λ), and the desired value is λ. As n→∞, R(n) does indeed converge in mean-square to λ because of the convergent properties of the binomial distribution. We will use this version of the law of large numbers for the remainder of the paper.

[12] By definition, a free-rider in our model contributes nothing to the firm. We do not ascribe a utility function to a free-rider because their actions are bound by this definition. In this sense a free rider may be boundedly rational because, as shown in Fernandez and Nahata (2009), even a self-interested consumer can have a strategic interest in contributing to a PWYW firm, but a free-rider in our model ignores this interest.

but we can substitute in $(1-\lambda) * \mu(A)$ for $\mu(A')$ and because $\lambda < 1$, the $(1-\lambda)$ terms cancel out, and we have that

$$MBR'(p^*) = MBR(p^*) = c$$

Let B' be the subset of L such that $i \in B'$ if and only if $v_i \leq p < v_i + w_i$ and $i \in L$, and as before, $\mu(A') \geq \mu(B') > 0$. Let $MR'(p^*)$ be the true marginal revenue of a PWYW firm if they were to choose $= p^*$. As before, the true marginal gains are the same as before, but only $\left(\mu(A') - \mu(B')\right) * \frac{a}{1-\lambda}$ is lost because those consumers who belong to B' will not change their contributions. Therefore

$$MR'(\rho^*) = p^* - \left(\mu(A') - \mu(B')\right) * \frac{a}{1-\lambda}$$

$$MR'(p^*) > p^* - \mu(A') * \frac{a}{1-\lambda} = c$$

which shows that the true marginal revenue of a decrease in the suggested minimum contribution exceeds marginal cost at p^*, which implies that the firm should increase the quantity sold by choosing ρ strictly less than p^* as desired.

What this analysis shows is that the presence of uniformly distributed free-riders does not change the fact that a PWYW firm chooses a lower "price" than a traditional firm. However, the addition of free-riders is likely to affect the profitability of PWYW relative to posted price. Let Π_{PP} be the maximum profit attained with a posted-price scheme. Let $\Pi_{PWYW}(\lambda)$ be the maximum profit attained using a PWYW scheme with a fraction λ of free-riders. Since $\Pi_{PWYW}(0) > \Pi_{PP} > \Pi_{PWYW}(1)$ and $\Pi_{PWYW}(\lambda)$ is decreasing in λ, there must be a critical value of $\lambda^* \in (0,1)$ such that the PWYW firm generates more profit if and only if $\lambda < \lambda^*$. Therefore when the proportion of free-riders is sufficiently small, a PWYW scheme represents a Pareto improvement over posted prices because firms and consumers are better off.

While deadweight loss is typically associated with a monopolist restricting quantity, when free riders are present and there is a positive marginal cost of production a different form of efficiency loss emerges: cost overruns. In other words, there are free-riders whose willingness to pay is less than the marginal cost of production who nevertheless receive the product. This is a loss of efficiency relative to the posted price scheme where such consumers would certainly not receive the product. The presence of free riders eats into the firm's profit, but if $\Pi_{PWYW}(\lambda) > \Pi_{PP}$ then the addition of infra-marginal consumers and benefits of endogenous price discrimination must compensate for this loss, and indeed the PWYW scheme is still welfare enhancing.

4.2 Discrete Demand Case

The addition of free riders to discrete demand can produce ambiguous results. If the identity of free riders is known by the firm, it is possible that a PWYW firm actually chooses a suggested minimum which is above the benchmark monopoly price. Consider the result if all the consumers with $z_i = \rho^*$ happen to be free-riders, where ρ^* is the optimal suggested minimum in the absence of free riders. (Recall that there must be at least one consumer with $z_i = \rho^*$.) In this case, there is no incentive for the firm to keep ρ at

ρ^*, and they will be strictly better off by increasing ρ to z_j , where consumer j has the next highest willingness to pay among non free-riders[13].

For a more concrete exploration of the effect of free-riders on the feasibility of PWYW, consider the example of Section 3.1. The realization of which consumers turn out to be free riders will have drastic consequences on the profitability of PWYW compared to traditional posted price, with the general rule that the higher the z_i of the free riders, the more devastating it will be to the PWYW firm. Instead of looking at specific realizations of free-riding behavior, it is more enlightening to consider the ex-ante decision of pricing scheme, knowing only the probability that any one consumer will be a free rider. Assume that each of the 10 consumers in the example given in Section 3.1 are chosen to be a free rider with probability λ. By assigning an independent probability of being a free rider to each unit sold, we find the marginal revenue of selling the 7th unit is $20(1-\lambda)$, and if $c = 10$, the firm will choose to sell 7 units if $\lambda < \frac{1}{2}$ as the expected marginal revenue of that unit exceeds marginal cost. The total cost comes from the units sold to the seven customers who will surely participate as well as the three customers who will get the good with probability λ. Therefore, the firm's PWYW expected profit, $\Pi_{PWYW}(\lambda)$, is

$$\Pi_{PWYW}(\lambda) = 440(1-\lambda) - (70 + 30\lambda)$$

while $\Pi_{PP} = 375 - 50 = 325$. Comparing these, we find that the PWYW scheme is the more profitable ex-ante pricing strategy if $\lambda < \frac{55}{470} \approx 0.117$, i.e. the critical proportion of free-riders in Example 1 with $c = 10$ is $\lambda^* \approx 0.117$. As c increases, the benefit from selling more units decreases, and the firm would need ever fewer free-riders in order to make PWYW the most profitable strategy.

This comparison shines light on the, perhaps tenuous, feasibility of the PWYW scheme when compared to a traditional posted price in the presence of free riders. It is important to recall that we are not making the unfair comparison of a market with warm glow to a market without warm glow. In fact, consumers' warm glow values are included in their willingness to pay for both pricing schemes, and many are purchasing a product for far more than their intrinsic valuation for it. Therefore, the difference between posted price and PWYW is not due a change in consumers' willingness to pay, but instead the lack of endogenous price discrimination when prices are posted because we have made the behavioral assumption that all consumers' contributions collapse to the posted price when such a price exists.

4.3 Suggested Minimum Contribution Equal to Zero

In this section we consider the profitability of a PWYW firm when the suggested minimum contribution is fixed at zero. Equivalently, we consider the case where there is no minimum contribution norm, perhaps because the concept of price does not readily apply or the clientele would not normally expect to pay anything for the good. The consumers in this case are not free-riders because they may contribute to the firm, however their only contributions would come from the part of their utility which

[13] It is important to note that this argument does not imply that setting $\rho = z_j$ is globally optimal for the firm, merely that it is an improvement over ρ^* . It is possible that the addition of free riders decreases the optimal suggested minimum.

values giving a gift to the firm. From Equation 4, we see that each consumer will obtain one unit of the good and make a contribution of $x_i = w_i$, and the firm's profit using PWYW is $\sum_{i=1}^{N} w_i - Nc$, which may or may not be higher than the profit of a tradition posted price scheme.

Consider setting $\rho = 0$ in Example 1. Then revenues are equal to 225, which is less than the revenue from a posted price scheme of 375. Regardless of marginal cost, PWYW is not optimal. Similarly, if $\rho = 0$ in Example 2, revenues are 150 with PWYW and 300 with posted prices. It follows that when consumer demand is approximately equally due to the intrinsic valuation of the good and the warm glow of contribution, then allowing $\rho = 0$ will likely render PWYW impractical. A cup of coffee is an example of such a good, because the intrinsic value of the coffee is a large reason customers come to the coffee shop in the first place. On the other hand, if there is a good with low v_i and high w_i, then PWYW with $\rho = 0$ may still dominate a standard posted price scheme. An example of this type of good may be souvenir photos from an amusement park with proceeds going to charity. It is likely that consumers in the study by Gneezy et al. (2010) did not particularly value their souvenir photos to a great degree (or else they would have purchased them more often when charity is not involved.) Rather, the demand for the photos was largely driven by the warm glow of contributing to charity and setting $\rho = 0$ was successful.

5 Discussion and Extensions

The flavor of the results of this paper is robust to different ways of interpreting the generosity of customers of PWYW firms. For example, suppose consumers believe that there is a market benchmark price, p^*, which they would otherwise expect to pay. If a PWYW firm sets $\rho < p^*$, consumers believe they are receiving a "gift" of $p^* - \rho$. Furthermore, assume as a behavioral regularity that customers reciprocate with a gift equal to $\gamma(p^* - \rho)$ beyond the suggested minimum of ρ, with $0 < \gamma < 1$, unless by doing so they will spend more than the good is worth to them. A number of laboratory experiments (Fehr, Kirchsteiger, and Riedl, 1993, e.g.) and field experiments (Falk, 2007, e.g.) support the existence of this type of reciprocity, known as gift exchange. Typically, reciprocity is regarded as a hardwired behavioral phenomenon in certain individuals who "are obligated to the future repayment of favors, gifts, invitations, and the like." (Cialdini, 1992, p. 211, as quoted in Falk, 2007) Therefore, given the assumption of consumer reciprocation at a rate of γ, a consumer with valuation of v_i will make a donation to the firm equal to $x(\rho)$, where

$$x_i^*(\rho) = \begin{cases} \rho + \gamma(p^* - p) & \text{for} \quad 0 \le \rho \le \dfrac{v_i - \gamma p^*}{1-\gamma} \\ v_i & \text{for} \quad \dfrac{v_i - \gamma p^*}{1-\gamma} < \rho \le v_i \\ 0 & \text{for} \quad v_i < \rho \end{cases} \tag{6}$$

Note that consumer contributions, $x(\rho)$, given the gift exchange interpretation of consumer behavior, are similar to the consumer contributions given the warm glow of patronization, given in Equation 4, in an important way: in both cases there are some consumers whose contributions are less responsive to changes in ρ than the customers of a traditional single posted price firm would be. Therefore, the PWYW firm incurs less revenue loss from those consumers who are already receiving the good than a traditional firm would when reducing its price. For this reason, the gift-exchange equivalent of Propositions 1 and 2 from Section 2 are also valid, and can be proved using exactly the same intuition.

The real world implications of our model depend on the fact that consumers are responsive to the suggestions of the firm when it comes to how much they should contribute, that most consumers will not free ride, that they wouldn't simply donate money to the firm without receiving something in return, and that they might give more than the firm suggests. We believe that while it is rare for a firm to have a clientele that meet all of these standards, it is certainly possible[14]. The fact that key parameters for the success of PWYW are attributes of the customers is apparently recognized by the chairman of Panera, who is quoted as saying, "It's a test of human nature. The real question is whether the community can sustain it" (Strom and Gay, 2010).

An alternative to our norm-based explanation for consumer responsiveness to the suggested minimum contribution is that the suggested minimum is a signal about the firm's underlying costs. There could be a fixed cost that a firm needs to recover on a regular basis to survive. If the suggested minimum donation is a signal to the customer about the level of contribution needed for the firm to stay viable, a consumer concerned about the continued existence of the firm is likely to be very responsive to the suggested minimum.

Finally, the expansion of Lentil as Anything and the profitability of Calvin's Coffee Shop in Tallahassee demonstrate that there are conditions in which a social norm of a minimum contribution is widespread enough for successful implementation of pay-what-you-want. To better understand the pay-what-you-want business model, we believe that there are open questions which deserve further consideration. For example, what characteristics of a firm drive the widespread acceptance of a minimum contribution social norm? In order to provide pay-what-you-want firms with a more concrete economic analysis, we must continue to synthesize our understanding of how gift-exchange works, the warm glow an individual receives as a result of giving, and the tendency to adhere to in-place social norms.

[14] Panera selected the city of Clayton, Missouri, a suburb of St. Louis, to introduce the PWYL pricing scheme. Clayton has a relatively homogeneous population and a large collection of professionals with a median family income of $107,346 (Census, 2000). The location could be explained by the company's roots in St. Louis; however, we inquired about the specific reasons for choosing Clayton and received no response from Panera management. Our belief is that a homogenous population provides the best opportunity for such a pricing scheme to succeed since norms of behavior would be more stable.

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