Pay What You Want as a Marketing Strategy in Monopolistic and Competitive Markets

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Pay what you want (PWYW) can be an attractive marketing strategy to price discriminate between fair-minded and selfish customers, to fully penetrate a market without giving away the product for free, and to undercut competitors that use posted prices. We report on laboratory experiments that identify causal factors determining the willingness of buyers to pay voluntarily under PWYW. Furthermore, to see how competition affects the viability of PWYW, we implement markets in which a PWYW seller competes with a traditional seller. Finally, we endogenize the market structure and let sellers choose their pricing strategy. The experimental results show that outcome-based social preferences and strategic considerations to keep the seller in the market can explain why and how much buyers pay voluntarily to a PWYW seller. We find that PWYW can be viable on a monopolistic market, but it is less successful as a competitive strategy because it does not drive traditional posted-price sellers out of the market. Instead, the existence of a posted-price competitor reduces buyers' payments and prevents the PWYW seller from fully penetrating the market. When given the choice, most sellers opt for setting a posted price rather than a PWYW pricing strategy. We discuss the implications of these results for the use of PWYW as a marketing strategy.

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1. Introduction

In several industries—including museums, software, and charity sales—some sellers use a pricing strategy that lets buyers pay what they want for the goods or services provided. The band Radiohead used it to sell a new music album online; restaurants in London, Berlin, and the Panera Cares community cafes in several cities in the United States let their buyers pay what they like for lunch; a theatre near Frankfurt tried it for generating revenue from movie screenings (Kim et al. 2009); and an amusement park in California did the same for souvenir photos (Gneezy et al. 2010). Other examples include churches, museums, software, and charity sales. Profit results are mixed, ranging from a reported success for Radiohead to a loss for the movie theatre. But in all cases, many customers were willing to pay positive prices voluntarily, and some sellers have been using "pay what you want" (PWYW) profitably for many years now.

In this paper, we report on several induced-value laboratory experiments with PWYW as a pricing strategy in monopolistic and competitive markets. The lab experiments are designed to identify the causal factors that determine the success and viability of PWYW. First, we identify which motivations induce buyers to pay positive (and often quite generous) prices voluntarily. We find that positive payments are mainly driven by (outcome-based) social preferences such as altruism or inequity aversion and by the strategic motive to keep the seller in business. We do not find evidence for intention-based reciprocity. Second, we compare the behavior of buyers on a monopolistic market with only one PWYW seller to their behavior on a duopolistic market in which a PWYW seller and a traditional seller offering posted prices compete. We find that a significant minority of buyers prefer to buy the product from the traditional seller. Furthermore, the posted price of the traditional seller acts as a reference point that reduces the prices buyers are willing to pay voluntarily to the PWYW seller. Thus, PWYW is less profitable on a competitive market but still viable under our experimental conditions. Finally, we let sellers choose

whether to use PWYW or a posted price. Choosing PWYW if the other seller charges a posted price is a very aggressive strategy that takes away most of the market share of the competitor and reduces his profit significantly, but the PWYW seller makes an even lower profit. However, if the other seller uses PWYW, then choosing PWYW as well relaxes competition and increases profits of both sellers.

The literature proposes three main reasons for why PWYW can be an attractive pricing strategy. First, PWYW is a means of endogenous price discrimination because different consumers pay different prices for the same product even though no exogenous constraints are imposed on them. Customers who are fair minded pay more than customers who are selfish, and a fair-minded customer may pay a higher price the higher his valuation for the product or the higher the seller's production costs. In contrast to traditional price-discrimination methods, PWYW does not set a reference price. A buyer may not be willing to pay a high price for a product if he sees that the same product is sold at a much lower price to other customers or at another time or place. This problem is avoided by PWYW. However, to effectively use PWYW as a price-discrimination mechanism, one has to better understand the extent and nature of social preferences among potential customers in the market. Our experiments allow us to identify which factors have a causal effect on the prices paid voluntarily by consumers in anonymous PWYW markets.

Second, PWYW can be attractive for firms that want to maximize unit sales (Gneezy et al. 2010). Maximum market penetration is a natural objective for many nonprofit organizations (such as museums or churches), but it is also the objective of some commercial firms that want to make profits from selling a complementary product, enter a new market, realize experience curve gains, or achieve network effects. At first glance, PWYW should dominate giving away the product for free because it generates positive revenues that cover at least some of the production cost. However, there is some field evidence (Gneezy et al. 2012) showing that some people prefer buying at a posted price to buying from a PWYW seller, so PWYW need not maximize market penetration after all. We can show experimentally under what conditions PWYW is an effective strategy for maximum market penetration.

Third, PWYW can be used as a competitive strategy. PWYW effectively undercuts all competing sellers using posted prices and thus threatens to drive them out of the market. Furthermore, when only PWYW sellers remain in the market, competition is softer because sellers do not, by definition, compete on price. On the other hand, competing sellers using posted prices could negatively affect the profitability of PWYW. These posted prices could form an upper bound on

the prices that buyers are willing to pay voluntarily (Gneezy et al. 2012). Furthermore, a buyer may prefer to buy from a seller offering posted prices rather than enter moral deliberations about how much he ought to pay voluntarily. Our experiments show the conditions under which PWYW is viable as a competitive strategy.

Before discussing our main results in more detail, we briefly outline the experimental design. We induce different valuations for the buyers and different production costs for the sellers. A group of buyers and one seller or two sellers form a market and interact repeatedly for five periods in a row. Sellers can decide whether to make a costly investment in the quality of their product, which doubles buyers' valuations for it. In the base (monopoly) treatment, one seller has to use PWYW while interacting with three buyers for five periods. In each period, the seller decides whether to enter the market and whether to invest in the quality of his product. In the competition treatments, we have two sellers interacting with six buyers. In the competition treatment with fixed roles, one seller has to offer a posted price while the other seller has to use PWYW. In the competition treatment with flexible roles, sellers can choose their pricing method and the market structure is determined endogenously.

There are clearly many differences between a laboratory experiment and a real-world market, and we have to be careful in the interpretation of our results. Our subjects interact anonymously via a computer network with no scope for personal interactions. No complementary products exist for which PWYW can act as a loss-leader promotion tool, nor are network effects or learning-by-doing effects present that would make the seller interested in maximizing sales early in the product life cycle. These design features are chosen conservatively in that they tend to make it more difficult for PWYW to be profitable. Thus, if certain factors sustain the viability of PWYW and induce buyers to pay positive prices under the anonymous conditions of the lab, then they are likely to also have a significant effect in real markets in which there is personal interaction and sellers have additional motives for maximal market penetration. But, of course, there are also many limitations of lab studies. For example, if we find that some factors do not have a significant impact in the lab, we cannot conclude that they will have no effect in the real world either. The main advantage of a lab experiment is that it can be used to identify causal factors that affect behavior under tightly controlled conditions.

Our main results are as follows: Despite the conservative design, we find that almost all potential sellers who can choose between entering the market with PWYW pricing or staying out actually enter, invest in the quality of their products, and make positive

profits. Almost full market penetration occurs under monopolistic conditions. Some buyers take the product and pay nothing, but most buyers are willing to pay positive prices. By comparing the base treatment with a control treatment in which entry and investments are imposed exogenously, we can identify two reasons for why positive payments are made: First, buyers pay more the higher their own valuation for the product and the higher the seller's cost, but they do not react to the investment of the seller per se. This finding is consistent with theories of outcome-based social preferences such as altruism (Andreoni and Miller 2002) and inequity aversion (Fehr and Schmidt 1999) but not with theories of intention-based reciprocity (Rabin 1993). Second, some buyers pay positive prices in the early periods of the game to keep the seller in business, but they do not pay in the last period. This finding is consistent with reputation models (Kreps et al. 1982) in finitely repeated games with incomplete information, whereby self-interested buyers mimic the behavior of altruistic or fair-minded buyers in the early periods of the game.

Competition significantly alters the picture. When a competing seller is offering the product at a posted price, market penetration of a PWYW entrant is no longer full. A significant fraction of buyers turns to the seller offering posted prices. This finding is consistent with the hypothesis that some people dislike deciding on voluntary contributions but also with some models of outcome-based social preferences. Furthermore, with competition, the prices that buyers pay voluntarily are significantly lower than under monopolistic conditions. In fact, the posted price of the competing seller limits the amount that buyers are willing to pay voluntarily. Even though PWYW attracts a larger market share in a duopoly, posted-price selling turns out to be significantly more profitable. PWYW does better only if it is used by both sellers. However, when sellers can decide which pricing method to employ, the large majority opts for posted prices. Thus, PWYW is not successful as a competitive strategy. Nevertheless, if the seller is interested in maximizing market penetration at the expense of profitability, then PWYW can be attractive even under competitive conditions.

Our paper is related to three strands of the literature. First, it is related to a small empirical literature on PWYW pricing. Several field studies describe and analyze cases in which PWYW has been implemented in practice, including the rock band Radiohead and the record label Magnatune (Regner and Barría 2009), the Google answer service (Regner 2009), restaurants, snack bars, and cinemas (Kim et al. 2009, 2010; Riener and Traxler 2012), and sales campaigns of hotels and travel agencies (Gautier and van der Klaauw 2012, León et al. 2012). Gneezy et al. (2010) conducted a field experiment on the sale of photos in an amusement park,

showing that people pay much more if the PWYW seller announces that half of the revenues will be donated to charity. Our paper is the first to use a laboratory experiment to identify the causal effects that determine voluntary payments under PWYW and to study the potential of PWYW as a competitive strategy. The only other laboratory experiment on PWYW pricing that we are aware of is Mak et al. (2010), who consider an infinitely repeated game between the seller and a fixed population of consumers, and focus on how participants can coordinate to make PWYW viable even though they do not exhibit any social preferences.

Second, our paper is related to the experimental literature on trust games (Berg et al. 1995). In a trust game, the first mover has to decide whether to make an "investment" that benefits the second mover. Then the second mover has to decide whether to voluntarily return some of this benefit to the investor. For example, Fehr et al. (2007) consider the use of voluntary bonus payments in an experimental labor market. A worker decides how much effort to invest, which increases the gross profit of his employer. The employer observes the worker's effort and decides on a voluntary bonus payment for the worker. Even though the interaction is one shot, many employers reciprocate to high effort with high bonus payments. This response in turn induces many workers to spend high effort. Our experiment has a similar but richer structure and is adapted to the PWYW context. In particular, one seller deals with several buyers, raising the possibility of free riding. In addition, we vary costs and benefits of the parties, and the interaction is finitely repeated.[1]

Finally, our paper is related to the theoretical literature on social preferences that tries to explain prosocial behavior (see Fehr and Schmidt 2006 for a survey). If all people were only concerned about their own material payoffs, nobody would ever pay a positive price if the PWYW pricing mechanism were used (this prediction also holds in all of our experimental treatments because of the finite number of repeated interactions). However, there is substantial experimental and field evidence showing that many people are also concerned about fairness and reciprocity and are willing to sacrifice their own resources to achieve a more equitable allocation.

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[1] An experimental literature also exists on reputation mechanisms based on repeated interaction (e.g., Brown et al. 2004) and on customer ratings as provided by eBay or Amazon (e.g., Bolton et al. 2004). Here a seller has an incentive to deliver high quality to keep a good reputation. A seller who succumbs to the temptation to deliver low quality loses his reputation and is out of business in future periods. In PWYW markets, customers not only decide whether or not to buy, they also decide the price. Thus, they can punish the seller for delivering low quality by taking his product and paying zero, which is even more costly to the seller than losing a customer. On the other hand, customers have to actively support the seller by paying positive prices voluntarily if they want to keep him in business.

Several theories try to explain the observed behavior, including altruism (Andreoni and Miller 2002), inequity aversion (Fehr and Schmidt 1999, Bolton and Ockenfels 2000), and intention-based reciprocity (Rabin 1993, Dufwenberg and Kirchsteiger 2004). Moreover, prior work finds substantial population heterogeneity in individual social preferences (Andreoni and Miller 2002), giving rise to incomplete information each seller possesses about the preference types of the particular buyers he faces. We discuss the specific implications of the different theories for PWYW behavior within our experiments in more detail in §2.

The remainder of this paper is organized as follows. In §2, we discuss in more detail the three main reasons for using PWYW, relate them to the theoretical literature on social preferences, and derive predictions that we test in the experiments. In §3, we outline our experimental design and describe the experimental procedures. The results of the experiments and the tests of our predictions are discussed in §4. In §5, we conclude.

2. Theory and Predictions

This section discusses the three main advantages of PWYW over traditional pricing methods. We relate these arguments to the theoretical literature on social preferences and reciprocity, and we derive several general behavioral predictions that can be tested by our experiments. In Appendix A most of these predictions are derived formally for the setup and the parameters of our experiment in a model of outcome-based social preferences.

2.1. Price Discrimination

PWYW is a price-discrimination mechanism whereby different consumers pay different prices for the same product. Customers who are fair minded pay more than customers who are selfish, and fair-minded customers pay more the higher their valuation for the product and the higher the seller's production costs. With PWYW, price discrimination is endogenous in the sense that the seller does not exogenously impose different prices on different types of buyers or on different choices of buyers. It arises endogenously from the buyers' unconstrained behavior. Furthermore, PWYW has a potential advantage over other price-discrimination methods. A buyer may not be willing to pay a high price for a product if he sees that the same product is sold at a much lower price to other customers or at another time or place. PWYW avoids this problem because it does not set a reference point.[2] Thus, it price

discriminates without influencing consumers' reference prices.

But why would a buyer pay any positive amount if he is not required to do so? The traditional self-interest model predicts that all buyers will take the product and pay a price of zero. Even if there is a (finitely) repeated relationship and buyers are interested in purchasing the product in several periods, a standard backward-induction argument implies that the market unravels, that buyers never pay, and that a PWYW seller will never enter the market.

Theories of prosocial behavior predict that positive prices are paid voluntarily but they differ in their explanations for why buyers do so, and they come up with different predictions under what conditions people are willing to pay more. Understanding which theory drives behavior has important implications for the use of PWYW as a price-discrimination mechanism and for its overall viability. Theories of prosocial behavior can be grouped into three broad classes, as follows:

(a) Outcome-based theories of social preferences such as altruism (Andreoni and Miller 2002) or inequity aversion (Fehr and Schmidt 1999) argue that many people are not purely self-interested but also care about the well-being of others. They are willing to give up own resources to help another person, especially if the other person is worse off than they are. These models predict that the larger the buyer's benefit from consuming the product and the higher the seller's cost of production, the higher the payments will be.[3] In other words, PWYW pricing involves price discrimination and at least partial compensation of the seller. If other-regarding preferences are strong enough, buyers pay strictly more than the seller's marginal cost whenever their valuation is higher than the seller's cost, and forego a purchase otherwise. Beyond the scope of our experimental variation, outcome-based models of social preferences also predict that people are willing to pay more to a nonprofit organization or to a firm that is small and poor than to a large and rich corporation.

(b) Intention-based models of reciprocity (e.g., Rabin 1993, Dufwenberg and Kirchsteiger 2004) are based on the hypothesis that some people reciprocate to kind intentions that are expressed by kind actions. For example, if the seller chooses to offer his product using PWYW or if he makes a special investment that

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[2] However, there may still be other reference points shaping the expectations of customers, for example, the prices posted by competing sellers or posted prices used by the PWYW seller before he turned to PWYW.

[3] This is shown formally in Proposition 2 of Appendix A. It is interesting to relate the prediction that the buyer's price increases with the seller's cost to the "dual entitlement principle" by Kahneman et al. (1986). They discuss under what conditions buyers consider a price increase *proposed by the seller* to be fair. The dual entitlement principle implies that it is not fair for sellers to increase the price to exploit increased market power, but it is fair to increase the price if costs increase. Applied to our PWYW market, the dual entitlement principle implies that a fair buyer should pay a higher price if the cost increases.

increases the value of the product to the buyer, then such an action is interpreted as an act of kindness that the buyer is willing to reciprocate by paying a higher price. According to these theories, the buyer's payment does not depend on the wealth of the seller or on exogenous variations of costs and benefits, but rather on the actions taken by the seller. Thus, these models predict that if the seller takes an action that is beneficial to the buyer, for example, by offering the product using PWYW or by making a special effort to increase its quality, then a buyer who is motivated by intention-based reciprocity will react by paying a higher price, but he will not pay more if his valuation increases for reasons that are unrelated to the seller's actions.[4]

(c) Reputational models (e.g., Kreps et al. 1982) of finitely repeated games with incomplete information can explain why even purely self-interested buyers have an incentive to pay positive prices in early periods, as long as there are some fair-minded or reciprocal buyers who pay positive prices in all periods (including the last period). If the seller has incomplete information about the type of the buyer, self-interested buyers want to build up a reputation for paying positive prices that cover the seller's cost to keep the seller in business. The seller anticipates this behavior and is willing to enter and stay in the market. In the last few periods, a self-interested buyer randomizes whether to pay or not pay, whereas a fair-minded and reciprocal buyer continues to pay a positive price with probability one. The reputational model predicts that average prices decline when the market comes to an end.[5] Furthermore, they predict that if a competing traditional seller is present (offering the product by posting a price), then selfish buyers have a much smaller incentive to keep the PWYW seller in business, so the price they pay in early rounds will be lower. The reduced incentive suggests that PWYW is more likely to be viable under monopolistic than under competitive conditions.

Note that models of outcome-based social preferences as well as models of intention-based reciprocity and reputational models all assume heterogeneity in social preferences, so the three classes of models discussed above are not mutually exclusive. They give rise to the following three predictions.

PREDICTION P1. *If all buyers are purely self-interested, they will always pay zero prices and no seller will enter the market and invest. However, PWYW can be profitable and does achieve price discrimination if at least one of the following mechanisms applies*:

(P1a) *If some buyers have outcome-based social preferences such as altruism or inequity aversion, average PWYW prices are higher the higher the buyers' valuations and the higher the sellers' costs.*

(P1b) *If some buyers are motivated by intention-based reciprocity, average PWYW prices are higher if the seller chooses PWYW voluntarily and if he invests in the quality of his product.*

(P1c) *If there is some positive probability that some buyers pay voluntarily in all rounds, then self-interested buyers pay positive prices in early rounds to induce the seller to stay in the market. However, this incentive vanishes in the last period of each block or if a competing seller is offering the same product. Thus, average PWYW prices will decline over time and be lower with competition than on a monopolistic market.*

We know from the empirical literature and from several case studies that PWYW does achieve some price discrimination (e.g., Kim et al. 2009), but this literature cannot distinguish the reasons why price discrimination works. In an experimental study, we can change the parameters of the market exogenously and thereby identify causal effects for the behavior of buyers. Thus, we can test which of these three forces drives buyers' behavior and what their relative importance is. Our findings provide important insights regarding the conditions under which PWYW is most likely to be a successful price-discrimination strategy.

2.2. Market Penetration
In some situations, firms are more interested in maximizing the number of units sold rather than profits. For example, nonprofit organizations such as museums or churches typically want to attract as many "customers" as possible. Maximal market penetration also appeals to sellers who want to promote a complementary product, particularly if the (traditional) sale of the complementary product is highly profitable. For example, for the British rock band Radiohead, some argue that offering its album "Rainbows" on the Internet by using the PWYW mechanism dramatically increased the popularity of the album and thereby increased the profits from the (traditional) sale of the CD and the concert tour (*Wired Magazine* 2007). Furthermore, maximizing sales may appeal to a seller who wants to enter a new market, test a new product, generate network effects, or realize learning-by-doing effects.

PWYW seems to be an ideal strategy for maximizing market penetration. Of course, one can also achieve maximal market penetration by simply giving away the product for free. In fact, this is what many companies

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[4] Models of intention-based reciprocity are based on psychological game theory that assumes that the utility of a player depends not only on his material payoff (and the material payoff of his opponent) but also on his beliefs about why his opponent has taken a certain action. See Fehr and Schmidt (2006) for a survey and discussion of these models.

[5] These results follow immediately from textbook models of reputation building and the folk theorem for repeated games with incomplete information (see, e.g., Fudenberg and Tirole 1995, pp. 384–386).

do.[6] The advantage of PWYW is that it makes the product available to everybody free of charge, but it also generates positive revenues if some buyers pay positive prices voluntarily. As long as the potential transaction is efficient (as will be the case in our experimental design), the self-interest model as well as models of intention-based reciprocity and reputational models make the following prediction:

PREDICTION P2. *When the potential trade between the seller and the buyers is efficient, PWYW is a strategy that achieves maximal market penetration.*

Models of outcome-based social preference make the same prediction for a monopolistic market.[7] However, if there is competition between a PWYW seller and a posted-price (PP) seller, a buyer motivated by altruism or inequity aversion may also buy from the PP seller if this seller is worse off, so maximal market penetration need not be achieved.[8] We also note that when the potential transaction is not efficient (i.e., the seller's marginal cost is strictly higher than the buyer's valuation), the three classes of models do not come up with a clear-cut prediction about market penetration.[9] However, in only 22 out of 2,636 cases in all treatments of our experiment does the seller enter and offer PWYW, and a buyer's valuation is smaller than the seller's cost.

Even in markets with efficient potential trades, PWYW may not achieve maximal market penetration if some buyers experience additional psychological costs that our theoretical development does not consider. For example, a customer may feel uneasy about taking a product without knowing what he ought to pay. In fact, Gneezy et al. (2012) report on three field experiments showing that more people buy the product if it is offered at a fixed price than if the PWYW mechanism is used. They argue that concerns for self-image and identity drive this behavior. People feel bad if they pay less than the "appropriate" price, which causes them not to buy the product at all. The existence of such concerns suggests that the lower a customer's valuation, the less likely he is to accept the product under PWYW. Furthermore, if the product is offered both at a posted price and using the PWYW mechanism, a customer may prefer buying the product at the posted price rather than entering moral deliberations about what price he ought to pay a PWYW seller.

In our lab experiment, we can control the willingness to pay for the product of each customer and we observe whether he buys the product and how much he pays voluntarily. Furthermore, we can compare behavior under monopolistic and under competitive conditions. Thus, we can test how the reaction to PWYW is affected by these factors and whether and under what conditions PWYW is an effective market-penetration strategy.

2.3. Competition
PWYW can also be used as a competitive strategy. It can be either an aggressive or a conciliatory strategy depending on the pricing format used by the competitor. PWYW is an aggressive strategy if the competitor charges a posted price because the PWYW seller offers to give away his products for free (i.e., below cost), which threatens to drive out traditional sellers from the market. If the posted-price seller does not get any customers, he has to either leave the market or adopt PWYW as well. This incentive to respond in kind leads to the possibility of both sellers choosing PWYW in equilibrium.

When all sellers decide to use PWYW, then PWYW softens competition by eliminating price competition. Thus, if enough fair-minded or reciprocal buyers are willing to pay positive prices voluntarily and if production costs are low, then PWYW duopolists might achieve higher profits than posted-price duopolists engaged in fierce price competition.[10] These two considerations give rise to our third prediction:

PREDICTION P3. (P3a) *PWYW is a competitive strategy that drives traditional PP sellers out of the market.*

(P3b) *If buyers are sufficiently altruistic/reciprocal and pay (on average) prices that are sufficiently high, then there is an equilibrium in which both sellers use PWYW. However, if buyers are less fair minded there is also an equilibrium in which both sellers offer posted prices.*

Prediction P3a is an immediate implication of P2. However, in the discussion of Prediction P2, we argued that P2 need not hold if buyers are motivated by outcome-based social preferences or if concerns for self-image and identity affect behavior. In this case, some customers may opt for a PP seller because they are happy to buy the product for a low posted price,

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[6] Examples include Internet service providers (such as Google) or media (such as radio and TV stations) that offer their services for free to one side of the market and sell complementary products (such as advertising) to the other side, or the government that offers public services (such as schools, roads, law enforcement, etc.) free of charge to users.

[7] See Proposition 1 in Appendix A.

[8] This is shown by Proposition 3 in Appendix A.

[9] In this case, parameters of the buyer's utility function exist such that the buyer refuses to trade if the transaction is inefficient. He does so to benefit the seller either because he is concerned about the seller's welfare, or because he wants to reciprocate the kindness of the seller by being so kind not to buy, or because he wants to keep the seller in the market.

[10] This result is also predicted in a theoretical paper by Chen et al. (2010), who consider the competitive implications of PWYW pricing in a horizontally differentiated duopoly. They confirm the above intuition by proving that when enough consumers care about distributive fairness, weaker horizontal differentiation results in more firms using PWYW to soften price competition.

but they would feel "cheap" if they paid this low price voluntarily. Thus, it is an open question whether traditional sellers will be driven out of the market.

The second part of P3 requires that there are enough buyers who are altruistic or reciprocal. These buyers pay positive prices no matter how many PWYW sellers there are. In contrast, a selfish buyer pays a positive price only because he wants to keep at least one seller in business. If there are several PWYW sellers it is less likely that all of them will leave the market. Thus, a selfish buyer has a lower incentive to pay a positive price if there are several PWYW sellers than in the case of a monopolistic PWYW seller. This argument suggests that PWYW is less viable in a competitive market than in a monopolistic situation.

Our last prediction concerns the nature of price competition between a PWYW seller and a PP seller. We propose that the posted price may act as a reference point for prices that customers pay the PWYW seller: buyers are unlikely to pay a higher price voluntarily to a PWYW seller than the posted price at which they can buy the same product from a PP seller. Furthermore, as long as two sellers are present, buyers have less of an incentive to pay high prices voluntarily to keep the PWYW seller in the market. Therefore, we predict the following:

PREDICTION P4. *If a PWYW seller competes with a PP seller and both types of sellers stay in the market, then the PWYW seller will get lower prices on average than if he is a monopolist.*[11]

In the experiment, we can test Predictions P3 and P4 rigorously. In a first step, we impose the market structure exogenously to test whether and under what conditions PWYW achieves full market penetration and a PWYW seller drives a traditional seller out of the market. Then we endogenize the market structure to see whether sellers choose PWYW as a competitive strategy. In both treatments, we can compare the prices paid voluntarily to PWYW sellers to the prices paid in the treatment with a monopolistic PWYW seller. A nice feature of the experiments is that the unit of observation is the entire market; that is, we not only observe the reaction of buyers to PWYW, but we also observe the interaction of buyers and sellers and whether and under what conditions sellers choose to employ PWYW to market their products.

3. Experimental Design

3.1. Base Treatment
The base treatment of the experiment considers one seller who faces three potential buyers, each of whom wants to buy one unit of the product to be produced by the seller. The seller is restricted to selling his product by using the PWYW mechanism; that is, each buyer can decide for himself what price to pay, including a price of zero.

Figure 1 outlines the timing of the base treatment game. At the beginning of each period (stage 1), the seller has to decide whether to enter the market. If he stays out, the period ends and the seller and the three buyers get a payoff of zero. If the seller enters he decides on an investment $I \in \{0, 1\}$ in the quality of his product at stage 2. The investment costs the seller two points and doubles the valuation of the product for all buyers.

At stage 3, all players learn the seller's marginal cost of production and the buyers' valuations. The production cost $c \in \{0, 1, 2, 3, 4\}$ is drawn randomly. Each buyer $b \in \{1, 2, 3\}$ is assigned a base valuation $\underline{v}^b \in \{2, 6, 10\}$ that is also drawn randomly and independently for each buyer. If the seller invested in a quality improvement at stage 2, the valuations of all buyers are doubled. Thus, the actual valuation of each buyer b is $v^b \in \{2, 4, 6, 10, 12, 20\}$. At stage 4, each buyer decides whether to buy the product and what price $p^b \geq 0$ to pay. The seller is obliged to supply the product to every buyer who wants to buy it at the price p^b that buyer b pays voluntary.

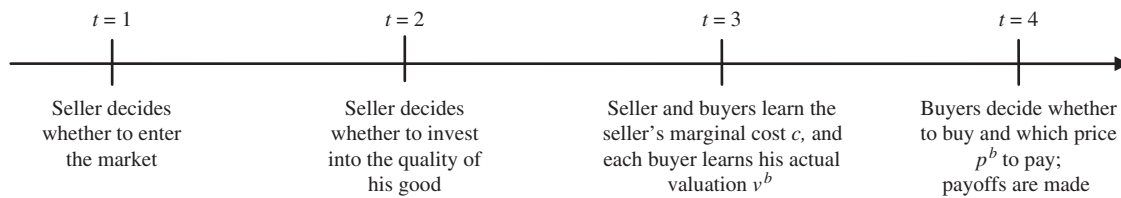Finally, payoffs are realized. The seller's monetary payoff is

$$M^s = \begin{cases} 0 & \text{if he did not enter} \\ & \quad \text{the market,} \\ \sum_{b=1}^{3} B^b(p^b - c) - 2I^s & \text{if he did enter the market,} \end{cases}$$

where $B^b \in \{0, 1\}$ and $I^s \in \{0, 1\}$ are indicator variables with $B^b = 1$ if buyer b decided to buy and $I^s = 1$ if the seller decided to invest. Note that the seller incurs the marginal cost c only if a buyer buys his product, whereas the investment cost of 2 is sunk and independent of the number of buyers. The monetary payoff of buyer b is given by

$$M^b = \begin{cases} 0 & \text{if the seller did not enter or} \\ & \quad \text{buyer } b \text{ did not buy,} \\ (1 + I^s)\underline{v}^b - p^b & \text{if the seller entered and} \\ & \quad \text{buyer } b \text{ did buy.} \end{cases}$$

This game is repeated in a block of five periods with the same group of one seller and three buyers. Then sellers and buyers are randomly rematched and a new block of five periods starts. Each session has 20 periods divided into four blocks. Each subject keeps his role as a buyer or seller throughout the entire session, but valuations and costs are randomly reassigned in each period. Before the experiment starts, the instructions (see Appendix B) are read aloud to all subjects.

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[11] This prediction also follows from a model of outcome-based social preferences (see Proposition 4 of Appendix A).

Figure 1   Sequence of Events in Each Period: Base Treatment

$t = 1$	$t = 2$	$t = 3$	$t = 4$
Seller decides whether to enter the market	Seller decides whether to invest into the quality of his good	Seller and buyers learn the seller's marginal cost c, and each buyer learns his actual valuation v^b	Buyers decide whether to buy and which price p^b to pay; payoffs are made

Note that the experimental design biases the results against the PWYW mechanism. The interaction is computerized and completely anonymous. No scope exists for communication or personal interaction between the subjects. The product is fictitious and reduced to its monetary value for the buyer. These factors make it relatively easy for a buyer to take the product and pay nothing.

The base treatment can tell us whether PWYW on a monopolistic market achieves full market penetration and whether and how much buyers are paying voluntarily. However, on its own the base treatment cannot tell us the causal factors that drive the observed behavior. To identify these factors, we conducted the following control treatment.

3.2. Exogenous Entry and Investment Treatment (EX E&I)

In the base treatment the PWYW seller decides in every period whether to enter the market and whether to invest. We compare the base treatment with a control treatment in which entry and investment is imposed exogenously as follows: For two sessions of the base treatment, we conducted two new sessions with exogenous entry and investment that exactly matched the seller's entry and investment decisions in the base treatment. Thus, for each period and each group of one seller and three buyers, we exogenously imposed the entry decision and the investment level that was chosen endogenously in the base treatment. Therefore, the valuations of the buyers are exactly the same in the two treatments. However, in the base treatment they have been determined by the voluntary entry and investment decisions of the sellers while they have been assigned by the experimenter in the exogenous entry and investment treatment (EX E&I). Furthermore, if a seller incurred the investment cost voluntarily in the base treatment, then the corresponding seller in the exogenous entry and investment treatment was forced to incur the same investment cost. Thus, the two treatments are identical except for whether the entry and investment decisions were taken voluntarily or imposed exogenously.

The exogenous entry and investment treatment turns off two of the three motivations for voluntary payments summarized in Prediction 1. If entry and investment are imposed exogenously, then buyers do not have

to pay positive prices to induce the seller to stay in the market and to invest. Furthermore, because sellers do not take any decisions in this treatment, buyers cannot be motivated by intention-based reciprocity. If there are no decisions, then there are no intentions to be inferred. Thus, if buyers pay positive prices in the exogenous entry and investment treatment, and if prices are increasing in the buyer's valuation and the seller's costs, then this is strong evidence for outcome-based social preferences.
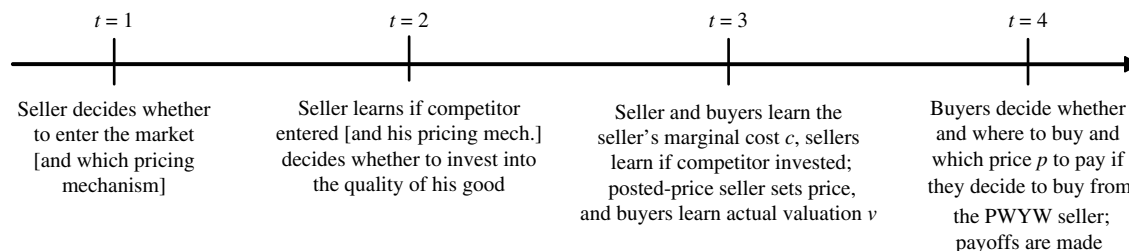
By comparing the exogenous entry and investment treatment with the base treatment, we can also find causal evidence for the existence of the other two motivations for paying positive prices. If we observe that buyers pay higher prices in the base treatment than in the exogenous entry and investment treatment, then this cannot be due to outcome-based social preferences. The higher prices could be due either to intention-based reciprocity or to the strategic concern to induce the seller to stay in the market and to invest in future periods. Note that in the last period of each block there is no future. Thus, strategic concerns are switched off both in the base treatment and in the exogenous entry and investment treatment, whereas intention-based reciprocity can still be a motivational force in the last period of the base treatment (where the seller decided to enter and to invest), but not in the exogenous entry and investment treatment. Hence, if we observe higher prices in the last period of the base treatment than in the last period of the exogenous entry and investment treatment, then this is causal evidence for intention-based reciprocity.

3.3. Competition: Fixed and Flexible Roles

The treatments described so far consider a monopolistic seller. We also conducted two competition treatments. In these treatments, we had two sellers and six buyers in one group. At the beginning of each period, each of the sellers decides whether to enter the market. In the competition treatment with fixed roles (COMP_FIX), one of the two sellers had to use PWYW and the other seller had to post a price. In the competition treatment with flexible roles (COMP_FLEX), each seller chooses whether to use the PWYW mechanism or to post a price. In both treatments, buyers observe which seller uses which pricing mechanism, whether a seller invested in the quality of his product, and what price

Figure 2 Sequence of Events in Each Period: Competition Treatments

$t = 1$	$t = 2$	$t = 3$	$t = 4$
Seller decides whether to enter the market [and which pricing mechanism]	Seller learns if competitor entered [and his pricing mech.] decides whether to invest into the quality of his good	Seller and buyers learn the seller's marginal cost c, sellers learn if competitor invested; posted-price seller sets price, and buyers learn actual valuation v	Buyers decide whether and where to buy and which price p to pay if they decide to buy from the PWYW seller; payoffs are made

(if any) is posted. If a buyer bought from the PWYW seller, he determined which price to pay. If he chose the seller with the posted price, he had to pay the posted price. Both sellers are randomly assigned the same marginal cost $c \in \{0, 1, 2, 3, 4\}$. Figure 2 outlines the timing of the game in the competition treatments.

The competition treatments are designed to test the effect of competition on behavior in PWYW markets. First, if a competing seller is present, buyers have to be less concerned about keeping the PWYW seller in business. Thus, if we observe lower prices in the competition treatments than in the base treatment, this is additional independent evidence that strategic concerns are important.

Second, we can test whether Prediction P2, saying that PWYW achieves maximum market penetration, also holds if another seller offers the same product at a posted price. This is closely related to Prediction P3, which claims that a PWYW seller will drive a seller using posted prices out of the market. If the PWYW seller does not corner the market, then some other forces, such as concerns for self-image or altruism, must be affecting behavior.

Third, the competition treatments allow us to test P4, which predicts that the price charged by a traditional seller acts as a reference point that limits the prices paid voluntarily.

Finally, the competition treatment with flexible roles allows us to see whether sellers prefer PWYW or posted prices and which form of competition will arise in equilibrium. In COMP_FLEX, sellers could choose whether to use the PWYW mechanism or to post prices. According to Prediction P3, if one PWYW seller faces one PP seller, then the PWYW seller will get all consumers and the PP seller makes a profit of zero or a loss (if he invested). If both sellers offer posted prices, Bertrand competition will drive down prices to marginal costs, and profits are also (close to) zero or negative because of the sunk investment cost. Thus, offering posted prices does not seem to be attractive. Offering PWYW, on the other hand, eliminates price competition and appeals to consumers' fairness and reciprocity. If intention-based reciprocity drives consumers, they may behave even more reciprocally if the seller has chosen PWYW rather than been forced to use this pricing strategy

as in COMP_FIX. These arguments suggest opting for PWYW may be profitable. On the other hand, if consumers are motivated by outcome-based social preferences, they may also buy from a seller offering posted prices.[12] In this case, PWYW need not push a PP seller out of the market. If the PP seller survives, Prediction P4 suggests his price limits what buyers are willing to pay the PWYW seller voluntarily, which reduces PWYW profits. Furthermore, if most consumers are selfish and pay positive prices only for strategic reasons (to keep the PWYW seller in business), they have a much lower incentive to pay if they can rely on a second seller to supply the product. Again, this argument works against the profitability of PWYW. Because the unit of observation is an entire market, we can see how the interaction of buyers and sellers affects the profitability and viability of PWYW as a competitive strategy and how the market structure is formed endogenously.

We conducted the experiments at the Munich Experimental Laboratory for Economic and Social Sciences (MELESSA) of the University of Munich in 2011/2012 and the EX E&I treatment in 2013. We had four sessions for the base treatment and the COMP_FIX[13] treatment, and two sessions of the EX E&I treatment and the COMP_FLEX treatment, with 24 participants in each session, for a total of 288 subjects participating in the experiments. Each session of the base and EX E&I treatments had two matching groups with 12 subjects each and no interaction between subjects across matching groups. Subjects were undergraduate students from the University of Munich and the Technical University of Munich studying a broad range of majors. Experiments were computerized using the software z-Tree (Fischbacher 2007) and ORSEE (Greiner 2004). Sessions lasted about two hours (including the completion of a questionnaire). Subjects were paid their

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[12] See Proposition 3 in Appendix A.

[13] In the sessions of the COMP_FIX treatment, we had the subjects play two blocks of COMP_FIX followed by two of COMP_FLEX, which is why we have only two blocks in the COMP_FIX treatment. The observations of the COMP_FLEX treatment in blocks 3 and 4 are thus not directly comparable to the observations in the sessions with four blocks of COMP_FLEX. To be on the safe side, we use only the COMP_FLEX data of the sessions with four blocks of the COMP_FLEX treatment.

earning of all periods. On average, subjects earned about €18.8 (US$26.40 at the time of the experiments), which included a show-up fee of €4 (US$5.60).

4. Experimental Results

We organize the presentation and discussion of our experimental results according to the three main reasons for using PWYW: price discrimination, market penetration, and competition.

4.1. Price Discrimination

Our first prediction is that PWYW is a means of endogenous price discrimination because different consumers voluntarily pay different prices for the same product. Thus, we first need to test whether buyers make positive voluntary payments even in our setting that involves full anonymity and no personal interaction.

RESULT 1. *In all treatments, a large fraction of buyers who buy from a PWYW seller make substantial voluntary payments. Mean PWYW prices are significantly above zero and above production costs in all treatments. However, PWYW prices are significantly lower in the competition than in the monopoly treatments.*

In all treatments, payments are sufficient to cover the seller's cost and to generate positive profits if sellers invest in quality. If they do not invest, profits are close to zero or negative. There is a lot of heterogeneity in buyers' behavior. In particular, a significant minority of buyers pays zero.

Support for Result 1 is provided in Table 1. Comparing the base treatment with the two competition treatments, we find that buyers pay on average a price of 3.1 (of the experimental currency) to the PWYW seller in the base treatment, but only 2.3 and 1.7 in the COMP_FIX and COMP_FLEX treatments, respectively. A Wilcoxon–Mann–Whitney test comparing the average prices in each matching group of the base treatment and in each session of the COMP_FIX treatment shows that this difference is highly significant ($n = 12$, $p = 0.0174$), whereas the difference between average prices in COMP_FIX and COMP_FLEX sessions is not ($n = 6$, $p = 0.1649$). There is a lot of heterogeneity in buyers' behavior. Although many buyers pay fairly generous prices (rejecting the self-interest model), 19.3% of them pay zero in the base treatment. With competition, this fraction increases to more than one-third of all buyers. In the base treatment, more than 60% of the buyers pay a voluntary price that is strictly greater than the production cost of the seller. This fraction is reduced to about 40% in the competition treatments. In all treatments, investing pays off and sellers who invested make positive profits on average.

What determines how much buyers pay? Outcome-based theories of social preferences (P1a) predict that buyers pay more if their own valuation and the seller's

Table 1 Summary Statistics

Treatment	BASE	BASE match	EX E&I	COMP_FIX	COMP_FLEX
PWYW buy[a] (%)	96.7	97.3	96.3	73.9	89.7
PWYW price[b]	3.14[1]	3.24[3]	2.66[3]	2.33[1,2]	1.67[2]
PWYW price last period[b]	2.53	2.82[4]	2.74[4]	2.25	1.89
PWYW price invest[b]	3.46	3.44[5]	2.77[5]	2.43	1.88
PWYW price no invest[b]	1.47	1.40[6]	1.65[6]	0.32	0.68
Percent zero payment[b] (%)	19.3	20.0	28.2	34.8	43.0
Percent price > prod. cost[b] (%)	62.3	64.7	56.7	49.8	39.1
PWYW seller entry (%)	85.6	82.9	82.9	92.5	14.6[c]
PWYW seller invest (%)	83.5	89.9	89.9	86.5	77.1
PWYW seller profit[a]	2.76	3.09	1.44	1.83	0.37
PWYW seller profit invest[a]	3.31	3.55	1.65	2.22	0.96
PWYW seller profit no invest[a]	0.03	−1.05	−0.45	−0.67	−1.63
No. of sessions (matching groups)	4 (8)	2 (4)	2 (4)	4 (4)	2 (2)
No. of subjects (buyers + sellers)	96	48	48	96	48

Note. "BASE match": only those sessions of the base treatment that are matched in the exogenous entry and investment treatment.
  [a]Given seller entry.
  [b]Given seller entry and buyer buying.
  [c]Percentage of sellers choosing PWYW.
Bivariate tests:
  [1]Wilcoxon–Mann–Whitney test (matching-group level): $n = 12$, $p = 0.0174$.
  [2]Wilcoxon–Mann–Whitney test (matching-group level): $n = 6$, $p = 0.1649$.
  [3]Wilcoxon signed rank test (individual level): $n = 563$, $p < 0.0001$.
  [4]Wilcoxon signed rank test (individual level): $n = 81$, $p = 0.8262$.
  [5]Wilcoxon signed rank test (individual level): $n = 511$, $p < 0.0001$.
  [6]Wilcoxon signed rank test (individual level): $n = 52$, $p = 0.8563$.

cost increase. Intention-based models of reciprocity predict that buyers pay more to reciprocate the seller for his investment in quality, whereas exogenous changes in valuations or costs have no effect (P1b). Prediction P1c suggests that buyers are driven by the strategic concern to keep the seller in the market, so their payments should decline over time and drop to zero in the last period of each block. By comparing the base treatment with the exogenous entry and investment treatment (and the competition treatments), we can discriminate between these predictions. Recall that the EX E&I treatment is based on the entry and investment decisions of the sellers in the first two sessions of the base treatment. The results for these two sessions are summarized in "BASE match." Note first that intention based reciprocity and strategic concerns cannot play a role in the exogenous entry and investment treatment. Nevertheless, we observe that in the EX E&I treatment, more than 70% of the buyers pay positive prices and 56.7% pay strictly more than the production cost of the seller. This is strong evidence for outcome-based social preferences (P1a).

Comparing the EX E&I with the base match treatment, we find that prices are significantly higher in the base match treatment.[14] Thus, outcome-based social preferences cannot be the whole story. Buyers may pay higher prices in the base match treatment either because they are motivated by intention-based reciprocity or for strategic reasons because they want to keep the seller in the market and to induce him to invest in the future. A closer look at the data reveals that the difference in prices between the two treatments is significant only if the seller invested (see Table 1, tests 5 and 6). This is consistent both with the interpretation that buyers reciprocate the past investment and the hypothesis that they want to induce the seller to also invest in the future. However, in the last period of each block there is no future, so the strategic concern cannot play a role. Comparing the prices paid in the last period of each block in the EX E&I and the base match treatment, we find no significant difference (see Table 1, test 4).[15] Thus, we do not find evidence for Prediction P1b (intention-based reciprocity). This suggests that the difference in prices between the two treatments in the other periods is driven by strategic concerns, which confirms Prediction P1c.

Additional support for Predictions P1a and P1c is given by the regressions reported in Table 2. We

Table 2   PWYW: Regression on Prices Paid

Model	(1)	(2)
Intercept	0.565 (0.509)	**1.050** (0.534)
Main effects		
Buyer valuation[a]	**0.192** (0.009)	**0.195** (0.009)
Production cost	**0.275** (0.052)	**0.225** (0.050)
Seller investment (DV)	**0.337** (0.133)	**0.296** (0.132)
Last round (DV)[b]	**−1.006** (0.172)	**−0.919** (0.173)
Block 1 (DV)[c]	**0.714** (0.152)	
Block 2 (DV)[c]	**0.458** (0.146)	
Block 3 (DV)[c]	0.084 (0.156)	
Interaction effects w/EXO E&I (DV)		
Buyer valuation × EXO E&I	**−0.059** (0.015)	**−0.063** (0.014)
Production cost × EXO E&I	0.103 (0.085)	0.139 (0.079)
Seller investment × EXO E&I	−0.017 (0.267)	0.034 (0.269)
Last round × EXO E&I	**0.720** (0.280)	**0.661** (0.279)
Block 1 × EXO E&I	**−0.553** (0.253)	
Block 2 × EXO E&I	**−0.495** (0.230)	
Block 3 × EXO E&I	−0.090 (0.249)	
Interaction effects w/COMP (DV)		
Buyer valuation × COMP	**−0.074** (0.015)	**−0.080** (0.015)
Production cost × COMP	−0.009 (0.076)	0.020 (0.075)
Seller investment × COMP	−0.300 (0.248)	−0.130 (0.239)
Last round × COMP	**0.790** (0.230)	**0.755** (0.229)
Block 1 × COMP	−0.246 (0.271)	
Block 2 × COMP[d]	−0.341 (0.274)	
No. of obs.	2,415	2,415
No. of subjects	216	216
R-squared	0.661	0.655

Notes. The dependent variable (DV) is measured in the experimental currency; only observations of buyers buying are included. Fixed-effect (FE) regressions with subject-specific fixed effects (robust standard errors in parentheses): (1) full model; (2) model without block dummies. Interaction effects: main effect × DV for treatment: Exo E&I or competition treatment. Coefficients in bold denote significance at the 5% level.
   [a]Valuation including effect of investment.
   [b]Baseline: rounds 1–4.
   [c]Baseline: block 4 (block 2 for the COMP_FIX treatment).
   [d]The COMP_FIX treatment had only two blocks and no PWYW entry in block 3 of the COMP_FLEX treatment.

regress PWYW prices paid on buyer valuations, seller's production cost, seller's decision to invest in the quality of the product, a dummy variable indicating the last round of a block and block dummies in one single regression for all treatments. Furthermore, we include all interaction effects of these variables and the EX E&I and competition treatments with the base treatment as baseline.[16] We also include buyer fixed effects to account for individual-level heterogeneity. We estimate two fixed-effects regressions with robust standard errors: (1) a full model and (2) a reduced model without block dummies.

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[14] A Wilcoxon signed rank test matching the behavior of each buyer in the Ex E&I treatment to the corresponding behavior of each buyer in the base match treatment shows that the differences between the prices paid in the two treatments is highly significant ($n = 563$, $p < 0.0001$). This is confirmed by a two sample *t*-test (df = 562, $p = 0.002$).

[15] This is confirmed by a two sample *t*-test (df = 80, $p = 0.8363$).

[16] We cannot include treatment dummies because of our fixed-effects model. We combine COMP_FIX and COMP_FLEX into a single competition treatment for the regression. A separate analysis (not shown here) reveals that the results are robust to just using the COMP_FIX data for the regression.

Recall that in our experiment, buyers (and sellers) are rematched after each block. Thus, observations may not be independent if subjects who previously interacted are rematched, with their decisions potentially being affected by their previous experiences with these subjects, and residuals may be correlated within class (i.e., group) with an intra-class correlation coefficient $\rho > 0$. In this case, the conventional ordinary least squares (OLS) variance $V_C(\hat{\beta})$ overestimates precision because the correct variance $V(\hat{\beta})$ given the error structure is higher (Angrist and Pischke 2008). However, Angrist and Pischke (2008, p. 232) show in their equation (8.2.5) that the magnitude of this effect also depends on the intra-class correlation of the regressors ρ_x (with average class size $\bar{n}$ and class size variance $(V(n_g))$:

$$\frac{V(\hat{\beta})}{V_C(\hat{\beta})} = 1 + \left[\frac{V(n_g)}{\bar{n}} + \bar{n} - 1\right]\rho_x\rho.$$

In this case, conventional OLS standard errors are not biased if the intra-class correlations of regressors ρ_x is zero. In our experimental design, buyer valuations and seller cost are randomly drawn and thus intra-class correlations between these variables are zero. Thus, there should be no bias in the standard errors in these parameters. Since our time-related regressors (e.g., block dummies) have some correlation by design, we additionally estimate reduced models without block dummies, which produce results consistent with the full models.

A potential solution to an intraclass correlation of residuals is to cluster standard errors at the class (i.e., group) level. In our case we have 12 independent matching groups for the monopoly treatments and 6 independent sessions for the competition treatments. However, as Cameron and Miller (2013) show, a small number of clusters tend to underestimate standard errors and is thus not recommendable to our data with 18 clusters.[17]

Table 2 shows that an increase in the valuation by one unit significantly increases the price buyers pay by 0.19 units in the base treatment. This effect is slightly (but significantly) lower in the EX E&I and the competition treatments. Furthermore, a one-unit increase of the seller's cost significantly increases the buyer's voluntary payment by 0.28 units in the base treatment, with no significant differences in the other treatments.[18] These findings suggest that a significant fraction of buyers is concerned about fairness and equity, which is consistent with Prediction P1a (outcome-based social

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[17] We performed several additional robustness tests (not shown here): (i) clustered errors at the individual (subject) level (216 clusters), (ii) clustered errors at the market level (182 clusters), as well as (iii) additional seller fixed effects. All tests indicate that our results are robust.

[18] The competition treatments are discussed in more detail in §4.3.

preferences). The seller's investment decision has an additional positive effect on the prices buyers pay beyond the effect already captured by the increase in his valuation in the base treatment. This could be interpreted as an indication that intention-based reciprocity (P1b) does play a role after all. However, in this case the effect should be significantly smaller in the EX E&I treatment (where intentions cannot play a role), which is not the case. Furthermore, we find a significant last-period effect in the base treatment. This confirms that some buyers make voluntary payments in periods 1–4 to keep the seller in the market, but withdraw their support in period 5. Note that the last period effect is significantly smaller (and close to zero) in the EX E&I and in the competition treatments. This is as it should be: In EX E&I all strategic concerns are switched off, so there should be no last period effect. In the competition treatments, keeping the PWYW seller in the market is less important, because a competing seller also offers the product. Thus, prices are lower with competition, and therefore the price reduction in the last round is significantly smaller than in the base treatment. All of this is consistent with Prediction P1c (strategic concerns). Finally, we observe a learning effect over the first two blocks as subjects get more experienced: Prices in the first two blocks of the base treatment are (significantly) higher than in the last block. However, the learning effect seems to disappear over time because there is no significant difference between block 3 and block 4 anymore. The learning effect is significantly smaller in the exogenous entry and investment treatment, possibly because this treatment is simpler because of the exogenous structure. These findings are summarized in the following result.

RESULT 2. Buyers pay positive prices even if entry and investment decisions are exogenously imposed. Furthermore, these prices increase with the seller's cost and the buyer's valuation, which is consistent with Prediction P1a (outcome-based social preferences). There is no effect of the entry and investment decision in the last period, in contrast to Prediction P1b (intention-based reciprocity). If buyers cannot affect the seller's future behavior (in EX E&I and in the last period of the base treatment) prices are significantly lower, as predicted by P1c (strategic concerns). Thus, the data support Predictions P1a and P1c, but we do not find evidence for Prediction P1b.

It is also important to note that we observe a lot of heterogeneity between subjects suggesting that different subjects are driven by different motivational forces. Some buyers are clearly fair minded and make large payments even in the last round of the market, whereas others consistently behave very selfishly. In fact, 12% of the subjects pay a price of zero in more than 80% of all periods in which they buy the PWYW product,

whereas 26.4% of the subjects pay positive prices in more than 80% of all periods. Furthermore, 14.4% of the subjects pay positive prices in the first three rounds of a market and nothing in the last round, a clear indication that they pay only to keep the seller in the market.

4.2. Market Penetration

Prediction P2 claims that PWYW achieves maximal market penetration. However, this prediction is controversial. Some buyers may feel uneasy about taking a product without knowing what the appropriate price is and decide not to take it or to buy from a competing seller offering posted prices. Furthermore, buyers who are motivated by outcome-based social preferences may also buy from a posted-price seller if his price is not higher than what they would have paid voluntarily to a PWYW seller. Our next result shows under what conditions these worries are warranted.

RESULT 3. When the PWYW seller is the only seller in the market, almost all buyers buy his product, as predicted by P2. However, when a competing seller is offering posted prices, a significant minority of buyers buy at the posted price.

Support for Result 3 is provided in Tables 1 and 3. In the base treatment and in the exogenous entry and investment treatment, almost all buyers buy the product (96.7 and 96.3%, respectively). In the competition treatments, there is a significantly higher fraction of buyers who do not buy from a PWYW seller (73.9 in COMP_FIX and 89.7 in COMP_FLEX). However, this could be driven by the fact that in some periods, the PP seller did invest while the PWYW seller did not. Thus, in the competition treatments, we have to restrict attention to those situations in which there is a PP seller and a PWYW seller and both sellers took the same investment decision.[19] A Wilcoxon–Mann–Whitney test comparing the fraction of buyers who did not buy from a PWYW seller in the monopoly treatments to the fraction of buyers who did not buy from a PWYW seller even though such a seller was available and took the same investment decision as a competing PP seller in the competition treatments shows that this difference is highly significant ($n = 18$, $p < 0.001$).[20]

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[19] This was the case in 81.3% of all cases. In the cases in which one seller did invest while the other one did not, almost all buyers bought from the seller who invested: 77.8% bought from the PP seller if he invested and the PWYW seller did not invest; 97.1% bought from the PWYW seller if he invested and the PP seller did not invest.

[20] We have 6 independent observations in the competition treatments (four session of COMP_FIX and two sessions of COMP_FLEX) and 12 independent observations of the monopoly treatments (four sessions with eight matching groups in the base treatment and two sessions with four matching groups in the EX E&I treatment). In fact,

Table 3   Logistic Regression on PWYW Buying Decisions

Model	(1)	(2)
Intercept	−2.814 (2.043)	−1.926 (1.166)
Main effects		
Buyer valuation[a]	**0.774** (0.224)	**0.779** (0.190)
Production cost	**−0.948** (0.243)	**−1.105** (0.242)
Seller investment (DV)	−1.018 (0.877)	−0.968 (0.889)
Last round (DV)[b]	1.974 (1.130)	**2.273** (0.903)
Block 1 (DV)[c]	0.519 (0.936)	
Block 2 (DV)[c]	−0.191 (1.445)	
Block 3 (DV)[c]	−0.956 (0.598)	
Interaction effects w/EXO E&I (DV)		
Buyer valuation × EXO E&I	−0.110 (0.297)	−0.324 (0.213)
Production cost × EXO E&I	**−2.064** (0.847)	**−0.861** (0.430)
Seller investment × EXO E&I	2.747 (1.587)	2.763 (1.541)
Last round × EXO E&I	4.998 (2.800)	1.638 (1.553)
Block 1 × EXO E&I	−2.160 (1.657)	
Block 2 × EXO E&I	0.899 (1.988)	
Block 3 × EXO E&I	3.954 (2.069)	
Interaction effects w/COMP (DV)		
Buyer valuation × COMP	**−0.856** (0.225)	**−0.857** (0.192)
Production cost × COMP	**0.974** (0.263)	**1.160** (0.262)
Seller investment × COMP	**5.112** (0.978)	**4.978** (0.991)
Last round × COMP	−1.665 (1.170)	**−1.998** (0.952)
Block 1 × COMP	−1.795 (1.310)	
Block 2 × COMP[d]	−0.767 (1.706)	
No. of obs.	1,352	1,352
No. of subjects	116	116
Pseudo *R*-squared	0.452	0.440

Notes. The dependent variable is 1 if the subject bought from a PWYW seller and 0 otherwise; only observations in which the seller entered the market are included. FE regressions with subject-specific fixed effects (robust standard errors in parentheses): (1) full model; (2) model without block dummies. Only subjects included with 0 and 1 for dependent var. Interaction effects: main effect × DV for treatment: Exo E&I or competition treatment. Coefficients in bold denote significance at the 5% level.

[a]Valuation including effect of investment.
[b]Baseline: rounds 1–4.
[c]Baseline: block 4 (block 2 for the COMP_FIX treatment).
[d]The COMP_FIX treatment had only two blocks and no PWYW entry in block 3 of the COMP_FLEX treatment.

It is interesting to note that almost all buyers who do not buy from the PWYW seller in the competition treatments do buy from the PP seller. There are only 4 out of 576 cases in which a buyer who could choose between a PWYW and a PP seller did not buy at all, but 113 cases (19.6%) where he chose the PP buyer.

The logistic regressions reported in Table 3 provide further evidence on when buyers did buy from a PWYW seller. In Table 3, we follow the same approach as for the price regressions in Table 2 by estimating two separate fixed-effects models with robust standard errors ((1) full model and (2) reduced model without block dummies) for a single regression across treatments. The probability of buying from a PWYW seller significantly increases

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all 6 observations of the competition treatments are greater than any of the 12 observations in the monopoly treatments. If we restrict attention to the sessions of the base treatment and of the COMP_FIX treatment, the same result obtains ($n = 12$, $p = 0.0066$).

with the buyer's valuation and decreases with the seller's production costs. This finding is consistent with outcome-based models of social preferences and suggests concerns about efficiency as an explanation for the few cases in which buyers did not buy.

To summarize, we find partial support for Prediction P2. PWYW achieves (almost) full market penetration under monopolistic conditions, but not if a competing seller is offering posted prices. Nevertheless, even under competitive conditions, PWYW can be more attractive than giving away the product for free, because it does generate positive revenues.

4.3. Competition

Predictions P3 and P4 concern the effects of PWYW as a competitive strategy. P3 predicts that PWYW drives out traditional PP sellers because a PWYW offer undercuts any positive posted price, so no consumer will choose the PP seller. Furthermore, if only PWYW sellers compete, P4 predicts that PWYW softens competition (compared to a situation with one or two PP sellers present) because no prices exist with which to compete. The next result shows that our experimental data clearly reject the first prediction and offer (weak) support for the second.

RESULT 4. (a) A significant fraction of about 20% of buyers shop with the PP seller when a PWYW seller is available, and PWYW does not drive the PP seller out of the market. Furthermore, buyers pay significantly lower voluntary prices to the PWYW seller if a competing PP seller is present than if the PWYW seller is a monopolist.

(b) When a PWYW seller is in the market, a competing seller makes higher profits if he also uses PWYW than if he chooses PP. However, two PWYW sellers facing each other make lower profits than two competing PP sellers. When offered a choice, the large majority (85%) of sellers choose posted prices.

As seen in §4.2, PWYW does not drive PP sellers out of the market, but a significant minority of buyers (19.6%) prefers buying from a PP seller. Here we show in addition that the presence of a competing PP seller reduces the price that PWYW buyers are willing to pay voluntarily. Comparing the average prices paid in the monopoly treatments (base and exogenous entry and investment) to the average PWYW prices paid in the competition treatments, the latter ones are significantly smaller.[21] Additional evidence is provided by the regressions reported in Table 4 for both competition treatments that include the price charged

[21] A two-sided rank-sum test (Mann–Whitney) confirms that mean prices per session (competition treatments) and matching group (monopoly treatments) differ significantly ($n = 18$, $p < 0.01$). At the individual level, this effect is (of course) much stronger ($df = 2{,}413$, $t = 6.67$).

Table 4   PWYW: Regression on Prices Paid (Including PP Ask Price)

Model	(1)	(2)
Intercept	**−1.953** (0.504)	**−2.093** (0.480)
Buyer valuation[a]	**0.114** (0.013)	**0.109** (0.013)
Production cost	**0.169** (0.063)	**0.156** (0.063)
Seller investment (DV)	0.114 (0.255)	0.181 (0.238)
Last round (DV)[b]	−0.102 (0.163)	−0.088 (0.160)
PP ask price	**0.186** (0.044)	**0.174** (0.043)
Block 1 (DV)[c]	−0.015 (0.257)	
Block 2 (DV)[c]	−0.405 (0.271)	
No. of obs.	612	612
No. of subjects	108	108
R-squared	0.702	0.697

Notes. The dependent variable is measured in the experimental currency; only observations of buyers buying are included. FE regressions with subject-specific fixed effects (robust standard errors in parentheses): (1) full model; (2) model without block dummies. Only cases with one PWYW seller and one PP seller included. Coefficients in bold denote significance at the 5% level.

  [a]Valuation including effect of investment.

  [b]Baseline: rounds 1–4.

  [c]Baseline: block 4 (block 2 for the COMP_FIX treatment).

  [d]The COMP_FIX treatment had only two blocks and no PWYW entry in block 3 of the COMP_FLEX treatment.

by the PP seller. We consider again two separate fixed-effects models with robust standard errors: (1) full model and (2) reduced model without block dummies. The results show that a reduction of the price charged by the PP seller significantly reduces the price that buyers pay voluntarily to the PWYW seller.[22] However, a closer look at the data shows that the vast majority of buyers (89.5%) pay a voluntary price to the PWYW seller that is smaller or equal than the price charged by the PP seller. Thus, the presence of a PP seller exerts a strong negative externality on the PWYW seller.

Which selling method should a seller choose? To answer this question, we have to restrict attention to the COMP_FLEX treatment. In COMP_FLEX, buyers know that the PWYW seller uses the PWYW strategy voluntarily. Thus, buyers may react differently compared to a situation in which they know the seller is forced to offer PWYW.[23] To be on the safe side, we

[22] Table 2 did not include the PP price to have the same predictors for all treatments. Table 4 includes the PP price and shows the regression results for the two competition treatments (using only those observations in COMP_FLEX where one PP seller and one PWYW seller enter the market). Separate regressions for the COMP_FIX and COMP_FLEX treatments yield consistent results.

[23] The effect could go in both directions. A buyer could voluntarily pay more if the seller is forced to offer PWYW because he pities the seller, or he could pay more to a seller who voluntarily offers PWYW in order to reciprocate. PWYW prices end up being higher in the COMP_FIX treatment, but the difference is not statistically significant. Note also that we observe PWYW prices only for the posted prices that are chosen by our PP sellers in the experiment. If for some reason the PP sellers would choose higher prices, then the effect of the PP seller on the profitability of PWYW might be less pronounced.

Table 5   Summary Statics for Different Market Structures with Competition

Treatment	COMP_FLEX			COMP_FIX
	PWYW vs. PWYW	PP vs. PP	PWYW vs. PP	PWYW vs. PP[a]
Market structure				
Average PWYW price paid[b]	2.08	—	1.54	2.33
Average PP price set	—	3.97	3.96	4.39
Average PP price paid[b]	—	3.45	4.47	3.99
Average PP markup set	—	2.27	2.56	2.91
Average PP markup paid[b]	—	1.78	2.94	2.68
Average PWYW market share[c]	0.5	—	0.88	0.74
Average profit of PWYW seller	2.42	—	−0.70	1.83
Average profit of PP seller	—	3.20	0.87	2.44
No. of markets	6	91	23	111

   [a]Contingent on market entry of both sellers (nine cases with PP monopoly excluded).
   [b]Given seller entry and buyer buying.
   [c]Given seller entry.

therefore restrict attention to COMP_FLEX (but Table 5 also reports the results of COMP_FIX for comparison).

   Table 5 shows that if both sellers choose PWYW, prices and profits are higher compared to a situation with one PWYW seller and one PP seller. With two PWYW sellers, buyers pay on average 2.08, whereas they pay only 1.54 if the PWYW seller faces a PP seller. If both sellers choose PWYW, each of them makes an average profit of 2.4, whereas a PP seller facing a PWYW seller makes an average profit of only 0.9. Thus, starting out from a situation with one PWYW and one PP seller moving to PWYW relaxes competition. Furthermore, if the subjects know this expected payoff structure, then it is a Nash equilibrium that both sellers choose PWYW. This finding offers some support for the second part of Prediction P3.

   On the other hand, if both sellers use posted prices, prices and profits are higher than if one seller uses PWYW while the other one uses posted prices. Even though there is Bertrand competition if there are two sellers using posted prices, prices are above marginal costs and profits are positive. This is at least partly due to the discrete price space.[24] Starting out from

[24] With a discrete price space there are two pure strategy Nash equilibria in the price setting game: one in which both sellers charge $p = c$ and one in which both sellers charge $p = c + 1$. The markup charged by the sellers on average is 2.27 and thus a little larger than 1. This is a common observation in experimental Bertrand games with two competing firms (see Dufwenberg and Gneezy 2000). We do not find any evidence for collusive behavior. If there was collusion, then prices should fall over time and in particular in the last period. However, there is no significant time trend. If anything prices go up over time.

a situation in which both sellers use posted prices the introduction of PWYW by one seller increases competition and reduces profits. With two PP sellers, each seller makes an average profit of 3.2, whereas he receives only −0.7 if he deviates to PWYW. Thus, it is also a Nash equilibrium if both sellers offer posted prices. The fact that a PP seller makes a higher profit than a PWYW seller if the two interact may have induced the large majority of sellers (85%) to opt for posted prices. This fraction increases over time. In the first two blocks, 63% of all markets are served by two sellers offering posted prices; in the last two blocks, this fraction increases to 88%.[25]

5.   Conclusions

There are many differences between an artificial laboratory experiment in which undergraduate subjects trade fictitious goods and real markets. In our experiments, the interaction between buyers and sellers is computerized and completely anonymous, there is no scope for communication or personal interaction, the product is fictitious and reduced to its monetary value for both parties, and no other people observe how much the buyer is paying. All of these factors make it relatively easy for a buyer to pay nothing, and bias our results against the viability of PWYW. Hence, if we observe that buyers do pay voluntarily under the experimental conditions and that certain factors make PWYW more profitable in the experiment, then these factors are likely to have a positive impact in the real world as well. On the other hand, our experiments lasted only for a few rounds. Thus, it is possible that the effects wear off over time, even though some firms are using PWYW for many years now. Furthermore, context effects related to a real product and purchase situation in the field may affect buyers' behavior. In a laboratory context with induced values, for example, the difference between buyers' benefit from a product and seller's cost of producing the product can be more salient compared to a real purchase situation, which may pronounce fairness concerns related to outcome-based social preferences. Hence, it is well possible that it is more difficult to induce buyers to pay voluntarily in the field. For example, in the case of the rock band Radiohead, about 62% of buyers did not pay for the download of the album "In Rainbows" (*Mail Online* 2007). Finally, it should be noted that if an effect is not significant in the lab, we cannot conclude that this factor is irrelevant under all circumstances.

[25] The fraction of markets served by two PWYW sellers is below 10% in all blocks with no time trend, whereas the fraction of markets in "disequilibrium" with one PWYW seller and one PP seller goes down over time. It is also interesting to note that in markets with two PP sellers, almost all sellers invest (97.3%), whereas in the other markets only 65%–82% of the sellers invest. This is consistent with our hypothesis that PWYW reduces competition.

Despite these caveats our lab experiments also have some important advantages over field studies. First of all, we can identify key causal factors that induce buyers to pay positive prices voluntarily. Second, we can show that some buyers prefer to buy at a posted price over PWYW holding everything else constant. This would be very difficult to show in the field where there are always some differences in transaction costs or other circumstances. Finally, we can compare how PWYW performs as a competitive marketing strategy against another PWYW seller as compared to another seller offering posted prices holding everything else constant—which we would never observe in the field. With these caveats in mind, our experimental study offers the following implications for pay what you want as a marketing strategy.

Our first result shows that the larger the buyers' valuation and the higher the seller's cost, the more buyers pay. This finding is consistent with models of outcome-based social preferences such as altruism or inequity aversion. This result suggests that PWYW is likely to be a more successful strategy for small shops and nonprofit organizations than for large and for-profit corporations. Furthermore, because an increase in production costs by $1 causes buyers to increase their voluntary payment by only 10¢ to 20¢, PWYW is best suited for products with low marginal costs that create a high value for customers, such as some digital products, museum or church visits, or tickets for some cultural events.

Our first result also suggests that buyers do not reciprocate to the investment of the seller per se; rather, they react predominantly to the value the investment creates. This negative result may be due to the anonymity of the interaction in the lab. If the buyer and the seller interact face to face, a friendly seller who makes an effort to deliver the best possible quality may be more likely to induce a buyer to pay more, either by triggering reciprocity or by shaming him to pay an appropriate amount. This additional force might explain why some restaurants or other service providers manage to survive with PWYW. However, our result suggests that with anonymous interaction, a costly investment on its own is not enough to increase voluntary payments. Buyers are willing to pay more only if the investment has a large effect on their valuations.

Furthermore, we have seen that a significant fraction of buyers pay for strategic reasons because they want to keep the seller in business. This finding suggests that a neighborhood shop or restaurant is likely to receive higher payments than a seller dealing with his customers only once.

Our second result shows that PWYW can be an attractive marketing strategy to achieve full market penetration, but only if no competing sellers of the same product are in the market. If there is only one

seller offering PWYW, almost all buyers with a positive valuation for the product "buy" it, and most of them contribute at least some positive amount to cover the production cost. This can explain why firms or organizations that want to maximize market penetration either for intrinsic reasons (such as museums, churches, and other nonprofit organizations) or for selling complementary products (such as the rock band Radiohead) often prefer PWYW to giving away the product for free. However, our experiments show that if competing sellers are offering similar products, this argument is less convincing. In this case, a significant fraction of buyers chooses a PP seller, and the price the PP seller charges reduces the voluntary payments made to the PWYW seller. Furthermore, competition does away with the need to pay more to keep the PWYW seller in business.

Finally, our third result shows that PWYW is not very successful as a competitive strategy. First of all, it fails to drive competing PP sellers out of the market. Some customers will always prefer not to buy from a PWYW seller but rather at a posted price. Second, if the competing PP seller stays in the market, buyers reduce their payments to the PWYW seller. Few buyers pay more to the PWYW seller than what they would have to pay the PP seller for the same product. Finally, even if both sellers offer PWYW, they make lower profits in our experiment than if both sellers were to use posted prices. However, PWYW does have the positive effect of reducing competition. If both sellers use PWYW, they are both better off than in a situation in which one of them chooses PWYW and the other chooses PP. Thus, if the other seller is committed to using PWYW, then for the second seller to use PWYW as well can be optimal. For example, if a museum uses PWYW, then another museum competing for the same visitors may want to do so as well.

Our results also raise some interesting new questions for future research. First, we observe that a significant minority of buyers prefers to buy at posted prices rather than from a PWYW seller, but we do not understand why. Is this behavior driven by social preferences for the PP seller, by the mental cost of coming up with the "appropriate" price that should be paid in this situation, or rather by concerns for self-image and identity, as suggested by Gneezy et al. (2012)?[26] What can be done to increase the acceptance of PWYW? Second, some but not all PWYW sellers make price "suggestions." What are the costs and benefits of using this strategy? Finally, we find that under monopolistic conditions, PWYW achieves almost full market penetration while still yielding positive revenues (or even profits). Thus,

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[26] Gneezy et al. (2012) refer to ideas of identity (Akerlof and Kranton 2000) and self-signaling (Bénabou and Tirole 2011) to explain their findings.

comparing PWYW to related marketing strategies, such as giving away products for free (Kim et al. 2014) or the so-called "freemium" pricing models, would be interesting. Which of these marketing strategies should be applied under which circumstances? These are important questions for future research.

Supplemental Material
Supplemental material to this paper is available at http://dx.doi.org/10.1287/mnsc.2014.1946.

Appendix A. Theoretical Predictions for Altruistic Buyers
In this appendix we analyze the experimental games under the assumption that buyers have outcome-based social preferences. In particular, we assume that buyers are altruistic, i.e., that their utility not only depends on their own monetary income but also on the monetary income of the seller. Thus, if buyer i buys the product and voluntarily pays the price p_i, his utility is given by

$$U_i^B = V_i(M_i) + A_i(M_S)$$

$$= V_i((1+I)v_i - p_i) + A_i\left(\sum_{j=1}^3 p_j - 3c - 2I\right), \quad \text{(A1)}$$

where $V_i(\cdot)$ is the utility of buyer i from his own monetary income M_i and $A_i(\cdot)$ is his utility due to altruism that depends on the monetary income of the seller (M_S). We assume that $V_i(\cdot)$ and $A_i(\cdot)$ are strictly increasing and strictly concave, or, in case of a purely self-interested buyer, that $V_i(\cdot)$ is strictly increasing and $A_i(\cdot) \equiv 0$.[27] Furthermore, for simplicity we assume that there is complete information and that prices can be chosen continuously.

Proposition 1. *Suppose that there is one monopolistic seller. In this case it is a weakly dominant strategy for a buyer with utility function (1) to buy the product if $(1+I)v_i \geq c$.*

Proof. The buyer has the option to buy and set $p_i = c$. If he does so, the monetary income of the seller is the same no matter whether or not he sells the product to buyer i. However, because $(1+I)v_i \geq c$, buyer i is better off buying than not buying. This argument is independent of what the other buyers are doing. Note that if trade is inefficient, i.e., if

$(1+I)v_i < c$, then the buyer may refrain from buying if he feels sufficiently altruistic about the seller.   Q.E.D.

The next proposition characterizes how much a buyer is going to pay:

Proposition 2. *Consider a monopolistic PWYW seller and suppose that $(1+I)v_i \geq c$ for all buyers $j = 1, 2, 3$. Buyer i with utility function (1) voluntarily pays*

$$p_i = \begin{cases} 0 & \text{if } \forall p_i \; \dfrac{\partial U_i^B}{\partial p_i} = -\dfrac{\partial V_i}{\partial M_i} + \dfrac{\partial A_i}{\partial M_S} < 0, \\[2mm] p_i(v_i, c, I) > 0 & \text{if } \exists p_i \text{ s.t. } \dfrac{\partial U_i^B}{\partial p_i} = -\dfrac{\partial V_i}{\partial M_i} + \dfrac{\partial A_i}{\partial M_S} = 0, \end{cases}$$

where $p_i(v_i, c, I)$ is uniquely characterized by

$$\frac{\partial U_i^B(p_i(v_i, c, I))}{\partial p_i} = -\frac{\partial V_i((1+I)v_i - p_i(v_i, c, I))}{\partial M_i}$$
$$+ \frac{\partial A_i(\sum_j p_j(v_j, c, I) - 3c - 2I)}{\partial M_S} = 0.$$

Furthermore, if $p_i(v_i, c, I) > 0$ then it is strictly increasing in v_i, c, and I.

Proof. The utility function $U_i^B(M_i, M_S)$ is increasing and strictly concave and $p_i \in [0, \bar{p}]$. Thus, the optimal p_i is uniquely characterized by the first-order condition $\partial U_i^B/\partial p_i = -\partial V_i/\partial M_i + \partial A_i/\partial M_S \leq 0$ and the complementary slackness condition $\partial U_i^B/\partial p_i \cdot p_i = 0$. Furthermore, by the implicit function theorem, we have that for an interior solution $p_i(v_i, c, I) > 0$,

$$\frac{\partial p_i}{\partial v_i} = -\frac{\partial^2 U_i^B/(\partial p_i \partial v_i)}{\partial^2 U_i^B/\partial p_i^2} = -\frac{-(1+I)(\partial^2 V_i/\partial M_i^2)}{\partial^2 V_i/\partial M_i^2 + \partial^2 A_i/\partial M_S^2} > 0.$$

Note that the second derivatives are all negative because of the strict concavity of $V_i(\cdot)$ and $A_i(\cdot)$. Furthermore, by the same argument, we have

$$\frac{\partial p_i}{\partial c} = -\frac{\partial^2 U_i^B/(\partial p_i \partial c)}{\partial^2 U_i^B/\partial p_i^2} = -\frac{-3(\partial^2 A_i/\partial M_S^2)}{\partial^2 V_i/\partial M_i^2 + \partial^2 A_i/\partial M_S^2} > 0$$

and

$$\frac{\partial p_i}{\partial I} = -\frac{\partial^2 U_i^B/(\partial p_i \partial I)}{\partial^2 U_i^B/\partial p_i^2} = -\frac{-v_i(\partial^2 V_i/\partial M_i^2) - 2(\partial^2 A_i/\partial M_S^2)}{\partial^2 V_i/\partial M_i^2 + \partial^2 A_i/\partial M_S^2} > 0.$$

Thus, $p_i(v_i, c, I)$ is strictly increasing in v_i, c, and I.   Q.E.D.

Consider now the competition treatment with one PWYW seller and one PP seller. Suppose that the PP seller offers a posted price $\bar{p}$. There are six buyers. We assume again that (some) buyers may be altruistic and have a utility function $U_i^B = V_i(M_i) + A_i(M_{PWYW}) + A_i(M_{PP})$.

Proposition 3. *Suppose that there are two competing sellers, one offering a posted price $\bar{p}$ and the other one offering PWYW. Furthermore, assume that both sellers took the same investment decision, i.e., $I_{PP} = I_{PWYW} = I$, and that $(1+I)v_i \geq c$ for all $i \in \{1, \dots, 6\}$. Then it can be optimal for some altruistic buyers to buy from the PP seller and pay the posted price $\bar{p}$.*

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[27] The latter case allows for the standard case of pure self-interest. Assuming other forms of outcome-based social preferences such as inequity aversion (Fehr and Schmidt 1999) or maximin preference (Charness and Rabin 2002) would yield similar results in the domain of favorable inequality for the buyer, but it would involve several case distinctions and thus be more complicated.

PROOF. Suppose that all buyers buy from the PWYW seller and pay prices $p_j \geq 0$, $j = 1, \ldots, 6$. Then the monetary payoff of the PWYW seller is $M_{PWYW} = \sum_{j=1}^{6} p_j - 6c - 2I$ while $M_{PP} = -2I$, so buyer i's utility is

$$U_i^B(PWYW) = V_i((1+I)v_i - p_i) + A_i\left(\sum_{j=1}^{6} p_j - 6c - 2I\right) + A_i(-2I).$$

If buyer i buys from the PP seller instead, his utility is

$$U_i^B(PP) = V_i((1+I)v_i - \bar{p}) + A_i\left(\sum_{j \neq i} p_j - 5c - 2I\right) + A_i(\bar{p} - c - 2I).$$

If buyer i's marginal utility from altruism for the PP seller at $M_{PP} = -2I$ is sufficiently large as compared to his marginal utility from altruism for the PWYW seller at $M_{PWYW} = \sum_{j=1}^{6} p_j - 6c - 2I > M_{PP}$, then he prefers to buy from the PP seller even if $\bar{p} > p_i$.

It is easy to construct an example showing that this can be the case. Suppose that $I = 1$, $c = 2$, $p_j = 3$ for all $j = 1, \ldots, 6$, $\bar{p} = 4$ and $v_i = 6$. Furthermore, assume that the utility functions are logarithmic, i.e., $V_i(\cdot) = A_i(\cdot) = \ln(3 + M)$. The constant 3 is added to make sure that the argument of the logarithm does not become negative. In this example, assuming that all the other buyers buy from the PWYW buyer, we have

$$U_i(PWYW) = \ln 12 + \ln 7 + \ln 1 = 4.4$$
$$< U_i(PP) = \ln 11 + \ln 6 + \ln 3 = 5.3.$$

Thus, in this example at least one buyer wants to buy from the PP seller. In fact, it is easy to show that if $v_j = 6$ for all $j = 1, \ldots, 6$, then in this example the only pure strategy equilibria have two buyers buying from the PP seller and four buyers buying from the PWYW seller. Q.E.D.

Now we compare the average prices that are paid to a PWYW seller if he competes against a PP seller to the prices that a PWYW seller receives if he is a monopolist. Recall that in the experiment a monopolistic seller faces three buyers, whereas a PWYW seller on a competitive market faces six potential buyers. To compare these two cases, we make the simplifying assumption that all buyers on both markets are identical, i.e., they have the same valuation of the product and the same utility function.

PROPOSITION 4. *Consider a monopolistic market with one PWYW seller and three identical buyers to a competitive market with one PWYW seller, one PP seller, and six buyers. Assume that in both markets all sellers have taken the same investment decision I and that all (identical) buyers buying from the monopolistic PWYW seller voluntarily pay $p_i = p > c$. If the PWYW seller on the competitive market gets more customers than the PP seller in equilibrium, then the price that he receives from his customers must be lower than the price p that a PWYW seller receives on a monopolistic market.*

PROOF. Consider a monopolistic PWYW seller on a market with three identical buyers who all pay $p_i = p > c$. For each of these buyers, the first-order condition

$$\frac{\partial U_i^B(p)}{\partial p_i} = -\frac{\partial V_i((1+I)v_i - p)}{\partial M_i} + \frac{\partial A_i(3p - 3c - 2I)}{\partial M_S} = 0$$

must hold. Consider now a competitive market in which the buyers have been replicated. Suppose that the PWYW seller gets $n > 3$ customers and that each of the buyers pays the same price p that is paid by each buyer on the monopolistic market. Then, by the concavity of $A_i(\cdot)$, we have

$$\frac{\partial U_i^B(p)}{\partial p_i} = -\frac{\partial V_i((1+I)v_i - p)}{\partial M_i} + \frac{\partial A_i(np - nc - 2I)}{\partial M_S} < 0,$$

so each of the buyers has an incentive to lower his price. Hence, in equilibrium the PWYW price in the competitive market must be lower. Q.E.D.

Appendix B. Experimental Instructions

B.1. Base Treatment

Roles. In the experiment there are two roles, which we denote as *buyer* and *seller*. Your role will be assigned to you randomly and will stay the same throughout the experiment. On the first screen you will be informed about which role was assigned to you.

Decisions and Procedures. The experiment consists of 20 periods, which are separated into four blocks of five periods each. You are asked to make the same type of decisions in each period.

At the start of each block, every seller will be connected to three randomly selected buyers. Each buyer is only connected to one seller. In every period, each seller can sell one unit of his product to each of his buyers.

The seller sells his product with the pay-what-you-want pricing mechanism. This means that each buyer can decide how much he wants to pay for the product. The seller has to sell the product to the buyer in any case, even if the buyer pays zero and the seller incurs a loss.

A block ends after five periods, and every seller will be matched with three other randomly selected buyers for the next block.

Each period consists of two stages:
• In stage 1 of each period, the seller decides whether or not he wants to offer a product in this period. If he does not want to sell anything, his profit and the profit of the three buyers assigned to him is zero and the period ends. If the seller offers the product, he needs to decide on whether or not he wants to invest in the quality of his product. Investment in quality costs two points but doubles buyers' valuations. Next, the seller learns his unit production cost for his product. These costs are between zero and four points and are randomly determined in every period.
• At stage 2, buyers learn their valuations of the product. This denotes the amount of money the buyer receives at the end of the experiment for the product in case he bought it. Their valuation depends on whether or not the seller invested in the quality of his product:
  ○ If the seller did not invest in the quality of his product, buyer's valuation is either 2, 6, or 10 points. The buyer's valuation is randomly selected from these values. Please note that it may happen that several buyers have the same valuation.
  ○ If the seller did invest in the quality of this product, valuations are doubled and are either 4, 12, or 20.

The buyers learn whether or not their assigned seller invested in product quality, and which costs accrue to the seller for investment and the production of the product. Finally, buyers decide whether they want to buy and how much to pay voluntarily. Every amount between 0 and 20 points is possible.

The instructions also included details on the calculation of seller and buyer profit as well as several control questions.

B.2. COMP_FLEX Treatment

Roles. In the experiment are two roles, which we denote as *buyer* and *seller*. Your role will be assigned to you randomly and will stay the same throughout the experiment. On the first screen you will be informed about which role was assigned to you.

Decisions and Procedures. The experiment consists of 20 periods, which are separated into four blocks of five periods each. You are asked to make the same type of decisions in each period.

At the start of each block, two sellers will be connected to six randomly selected buyers. In every period, each buyer can buy at most one unit of the product from one of the two sellers.

In every block, each seller can decide whether he wants to sell his product with a posted price or via the pay-what-you-want pricing mechanism. If the seller sets a posted price, a buyer who wants to buy from him has to pay this price. If the seller uses pay-what-you-want pricing, each buyer can decide how much he wants to pay for the product. The seller has to sell the product to the buyer in any case, even if the buyer pays zero and the seller incurs a loss.

A block ends after five periods. Then again two randomly matched sellers will be matched with six randomly selected buyers for the next block.

Each period consists of four stages:

• At stage 1 of each period, the seller decides whether or not he wants to offer a product in this period and whether he wants to sell it for a posted price or via pay-what-you-want pricing. If he does not want to sell anything, his profit is zero and the period ends for him.

• At stage 2, an active seller learns whether the other seller offers the product in this period and which pricing mechanism he chose. Then, each active seller has to decide whether or not he wants to invest in the quality of his product. Investment in quality costs two points and doubles buyers' valuations.

• At stage 3, the seller learns whether the other seller invested in the quality of the product. He also learns the unit production cost for his product (production costs are the same for both sellers). These costs are between zero and four points and are randomly determined in every period. The posted-price seller stets his price.

• At stage 4, buyers learn which sellers are active on the market and which pricing mechanism they chose, and which seller invested and what buyers' valuations are for the products of the sellers. The valuation denotes the amount of money the buyer receives at the end of the experiment for the product in case he bought it. The valuation depends on whether or not the seller invested in the quality of his product:

○ If the seller did not invest in the quality of his product, buyer's valuation is either 2, 6, or 10 points. The buyer's valuation is randomly selected from these values. Note that it may happen that several buyers have the same valuation.

○ If the seller did invest in the quality of this product, valuations are doubled and either 4, 12, or 20.

Furthermore, buyers learn which costs sellers accrue for investment and the production of the product. Finally, buyers decide whether and from which seller they want to buy. If they buy from the posted-price seller, they have to pay his price. If they buy from the pay-what-you-want seller, buyers decide how much they pay for the product. Every amount between 0 and 20 points is possible.

The instructions also included details on the calculation of seller and buyer profit as well as several control questions.

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