The Benevolence of the Baker: Fair Pricing under the Threat of Customer Anger

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This version: November 3, 2003

Abstract

I suppose that an actor is considered fair if other actors cannot reject the hypothesis that the first actor is somewhat benevolent towards them. Aside from being consistent with some observations in experimental games, this approach can explain several features of pricing when consumers judge the extent to which suppliers are altruistic towards them. Under some conditions, this expectation of firm altruism can explain price rigidity while also providing novel explanations for third degree price discrimination and for the existence of "temporary sales".

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"... man has almost constant occasion for the help of his brethren, and it is in vain for him to expect it from their benevolence only... It is not from the benevolence of the butcher, the brewer, or the baker, that we expect our dinner, but from their regard to their own interest. We address ourselves, not to their humanity but to their self-love..." Adam Smith, The Wealth Of Nations

Adam Smith was surely right in proclaiming that suppliers' hope for material gain provides the main impetus behind the supply of goods. However, this still leaves open the question of whether the benevolence of suppliers plays any role at all in market exchanges. Certainly, many firms spend resources proclaiming this benevolence towards their customers. Johnson & Johnson, for example makes an effort to tout its 50-year old one-page "corporate credo" which begins with: "We believe our first responsibility is to the doctors, nurses and patients, to mothers and fathers and all others who use our products and services. In meeting their needs everything we do must be of high quality. We must constantly strive to reduce our costs in order to maintain reasonable prices." Shareholders are mentioned last, and the credo ends with the words "When we operate according to these principles, the stockholders should realize a fair return."[1] It is conceivable that this firm is just "burning money" through this publicity, but too much effort is spent emphasizing the content of this message to make this interpretation plausible.

At the same time, consumers also appear to care about the benevolence of the firms that they deal with. Consumers irate over price gouging often accuse the offending firms of being "greedy" and "selfish". A consumer who responded to a gas station that raised its prices after the September 11, 2001 attack by picketing the station (and thereby leading the station to close) complained that the station had failed to honor the idea that "most Americans come together in times of trouble.[2]

This overt anger at price gouging is reflected in interview surveys where subjects are asked what prices they would consider "fair". Kahneman, Knetsch and Thaler (1986), for

[1]See, for example, http://www.jnj.com/our_company/our_credo_history/index.htm.

[2]"Quick Stop in Waunakee is picketed" *Wisconsin State Journal* September 13, 2001.

example, report that the vast majority of the people they interviewed regarded an increase in the price of snow shovels during a snowstorm as unfair. The use of the word fairness still leaves open the question of what it is about these price increases that people find so upsetting. As Hochschild (1981) reports, the meaning people assign to the word fairness is not uniform. Rather, this meaning varies both across people and across contexts. Fairness is related to a variety of norms of distributive justice, including ones based on strict equality, on responding to differences in need, on rewarding differences in investments, or on giving people access to neutral procedures. All these meanings may be related to Aristotle's principle of treating equals equally but, as Hochschild (1981) says, this principle is vague in that it does not define who is equal.

Economists have recently attempted to model fairness concerns explicitly. Rabin (1993), in particular, models equilibrium actions in a one-shot game and supposes that agent A regards agent B as fair if he expects B to take an action that is more generous than the other efficient actions that are available to him. Fehr and Schmidt (1999) and Bolton and Ockenfels (2000), who try to rationalize the outcomes of laboratory experiments including those of ultimatum games, model fairness as a direct concern for the strict equality of outcomes. The approach in this paper is more similar to Rabin (1993) in that I focus on intentions rather on outcomes *per se*. In practice, this difference in emphasis may not be all that important because benevolent intentions by opponents can easily lead to more equal outcomes than those that would result from more selfish intentions.

Still, capturing fairness in economic settings by supposing that it is equivalent to wanting others to be benevolent has some advantages. One of these is that, perhaps surprisingly, the altruism-based model I propose can explain the predominance of equal splits in ultimatum games with utility functions that are much more selfish than those that are needed to explain these outcomes in Fehr and Schmidt (1999) and Bolton and Ockenfels (2000). In particular, equal outcomes arise in my setting without supposing that people prefer to have a dollar in the pockets of their opponent rather than a dollar in their own pocket. Altruistic intentions turn out to be a powerful force for equality when these intentions need to be demonstrated with deeds. The reason is that people who want to demonstrate even small degrees of benevolence may need to be quite generous to distinguish themselves from more selfish individuals.

Another benefit of focusing on beneficent intentions is that, in the context of relationships between firms and households, this focus seems simpler than a focus on strict equality of outcomes. Defining what it means for outcomes to be equal between a firm and a household, for example, does not appear completely straightforward. Moreover, different households benefit differently from the offer to sell a good at a particular price, and this further complicates the issue of determining whether outcomes are equal. By contrast, the extent to which a firm is altruistic towards its customers seems to be something that is amenable to discussion and estimation in a broad range of circumstances. Empirically, too, benevolence on a firms' part seems consistent with what people regard as fair when it comes to pricing. Campbell (1999) asked her respondents about the fairness of various mechanisms that a toy store could use for allocating a single doll that it found in its warehouse just before Christmas, when the doll was in short supply. Auctioning the doll to the highest bidder and keeping the proceeds was widely seen as unfair. On the other hand, auctioning the doll and giving the proceeds to charity was commonly regarded as fair. This can be interpreted as saying that benevolent firms are seen in a better light than ones that seeks only to maximize profits, though other interpretations may well fit these particular facts.

My aim in this paper is to analyze the consequences of a particular model of firm benevolence for pricing. The model is closely related to the one presented in Rotemberg (2002), though this paper lets households have a sophisticated understanding of how benevolence on the part of firms affects equilibrium prices while the earlier one supposed that households used an intuitive but simple-minded model of firms behavior. The papers also differ in that the current one emphasizes consequences for micro observations on prices while the earlier one emphasized the aggregate consequences of monetary policy. What the papers have in common is that, in both cases, consumers care about the extent to which firms are altruistic towards them. If consumers believe that a firm has a minimal level of altruism, they buy from this firm normally. If, instead, consumers feel that the firm's altruism is insufficient, they reciprocate with anger.

I simplify the analysis in a number of ways, and thereby leave many open questions for subsequent work. I suppose, in particular, that the level of benevolence that consumers require of firms is in fact equal to the benevolence that firms feel for consumers. This seems like a good starting point for the analysis since it implies that consumers are rational in their expectations regarding firm behavior. It does, however, neglect the analysis of the forces that lead firms to be altruistic as well as the analysis of how firms with different levels of altruism fare in equilibrium.

I also make two simplifying assumptions regarding consumer anger with firms that are seen as insufficiently altruistic. The first is that all of a firm's customers have the same information so that they react in the same way to a firm's prices. The second is that the reaction to a firm that is seen as insufficiently altruistic consists of a cessation of purchases. What is essential about these assumptions is that there is a discrete reaction when the firm steps over a line. In practice, this reaction often takes the form of direct protests and calls for political intervention, both of which can be quite costly to firms. Another aspect of actual reactions to price gouging is that customers do not all react right away in the same manner. Rather, some outspoken customers take it upon themselves to convince others that the firm's acts are immoral and that the firm ought to change its behavior or face punishment. Whether any customers will react in this way, and whether they will garner support by, for example, getting media attention, appears to be somewhat unpredictable in that firms often find these reactions surprising. In my model, I capture this lack of predictability by supposing that firms are not well informed about the consumers' trigger points, even though this assumption is not easily squared with my assumption that all consumers react in exactly the same way.

A model of fair prices must obviously account for the lack of fairness that people feel when prices respond to the changes in demand I discussed above. Ideally, such a model would also account for a related observation, namely that many branded goods prices remain constant for long periods of time. This price stability seems more common among branded goods than among unbranded commodities, suggesting that periods of constant prices provide information to consumers about attributes of particular firms.

On the other and, many branded goods also have prices that seem to be variable on purpose. Branded goods firms often engage in price discrimination where different customers pay different prices for the same good. If this is seen as unfair, and Maxwell (1995) reports that people do see some price differences across customers as unfair, it raises questions about the extent to which firms are even trying to be fair. In addition, many branded goods alternate between being sold at "regular prices" and being "on special" (or having a "rebate"). If this is also seen as unfair, one could argue that the pressure on firms to act fairly is relatively weak. An element that gives this argument force is that there exist well articulated models of profit maximization that rationalize these forms of price discrimination.

It turns out, however, that benevolence is also able to explain these forms of price discrimination even in settings where selfish firms would charge uniform prices. Benevolent firms prefer charging high prices to individuals with low marginal utility of income while charging lower prices to those whose marginal utility of income is higher. This rationalizes the common practice of offering discounts to groups that are widely regarded as less well off such as the young and the elderly.

Intertemporal price discrimination is also advantageous to benevolent firms. Such firms may find it difficult to earn an adequate profit if they continuously charge a price that is so low that even individuals whose willingness to pay is low can buy it. By the same token, they often can earn a return that is sufficient to keep them in business by selling to these individuals on occasion, while charging a high price the rest of the time. This can rationalize regular "specials" even in settings where the elasticity of demand of various market segments is constant. These theoretical examples do not, obviously, prove that the observed forms of price discrimination are due to fairness considerations. They do, however, establish that these observations are not at all inconsistent with the importance of fairness in price-setting.

At the same time, firm altruism is consistent with constant prices - and stock-outs - in periods where demand rises dramatically. It is common, for example, for supermarkets to run out of bottled water before and right after hurricanes.[3]

When stores do increase their prices in such circumstances, and some stores do, consumers complain vociferously of "gouging".[4] These price increases may be painful to consumers not only because they reduce their real income but also because they lead customers to regret not having bought earlier. As long as this experience of regret is acute enough, altruistic firms will prefer to keep their prices constant. Interestingly, this mechanism can explain situations where prices remain constant when demand increases by a great deal, as in the case of a natural disaster, while they vary in response to smaller increases in demand. The reason is that an altruistic firm realizes that, in the former case, small price increases may not be very affective at allocating goods across customers since all customers are clamoring for the good at the same time.

The three implications of the model I just discussed above are based largely on pure altruism, and it is important to stress that the model incorporates not only firm altruism but also customers who become angry when firm altruism is insufficient. However, it turns out that even when both firm altruism and consumers' requirement that firms be altruistic are present, firms often end up charging the price that is dictated by their altruism alone. This result is almost certainly due in part to my assumption that the benevolence that customers expect from firms corresponds, in the typical case, to genuine feelings that firms actually have. This is not a full explanation, however, because the equilibrium offers in the the ultimatum game that I study are much larger than those based on pure altruism, even though the altruism of proposers is closely matched with the altruism demanded by responders.

The willingness of households to punish firms they deem to be unfair does affect one of my results concerning prices. It affects, in particular, the extent to which firms keep their prices constant even if their costs of production change. The assumption that firms internalize the distress of consumers whose price changes does, of course, rationalize some

[3]See, for example, "N.Va.'s Land Of Plenty Learns To Do Without," *Washington Post,* September 21, 2003.

[4]See, for example, "In praise of gouging," *The Globe and Mail,* January 24, 1998.

price rigidity under pure altruism. However, the model also predicts that this price rigidity is variable so that, in particular, the size of the minimum price increase that firms will implement depends on the firm's circumstances. When the firm feels that its original price is regarded as fair by its customers it is willing to countenance small price changes, while this is no longer true when it feels that customers are already dubious about its initial price. In the latter case, the benefits of raising prices are lower because this might lead to consumer anger. This rationalizes the rather diverse price increases observed by Carlton (1986) and Kashyap (1995), which stand in contrast with the behavior predicted by administrative costs of changing prices of the form considered in Barro (1972) and Sheshinski and Weiss (1977).

The paper proceeds as follows. The next section introduces my model of reciprocity based on altruism and shows that it can explain some experimental findings. I then turn in section 2 to a firm that sets prices for a single period. Section 3 studies a variant where the firm is better informed about the signals available to consumers. Section 4 is devoted to price discrimination while Section 5 deals with price rigidity in response to demand fluctuations. Section 6 is concerned with price rigidity when firms must produce different batches with different levels of marginal cost while Section 7 concludes.

1 A general model of "reciprocal" preferences

My focus is on consumers who purchase goods from firms. Before specializing the model to this context, I consider a more general one where two agents move in sequence. The first player, which will later represent a firm setting a price, chooses an action a_1 and then the second reacts by choosing a_2. The two agents have material payoffs, *i.e.* utility functions leaving aside any feelings the agents have for one another, given by U_1 and U_2 respectively. The two players' actual utility is given by

$$W_1 = U_1 + \lambda_1 U_2 \quad (1)$$

$$W_2 = U_2 + (\lambda_2 - \xi(\hat{\lambda}_1, \bar{\lambda}))U_1 \quad (2)$$

where λ_1 and λ_2 represent the unconditional levels of altruism of the two agents. The variable

$\hat{\lambda}_1$ represents the beliefs of agent 2 about λ_1 while the function ξ takes a value substantially larger than λ_2 if agent 2 can reject the hypothesis that $\lambda_1 \geq \bar{\lambda}$ and equals zero otherwise. This means that agent 2 is willing to incur significant costs to inflict harm on agent 1 if he can reject the hypothesis that agent 1's altruism is at least equal to $\bar{\lambda}$.

In supposing that an agent is more altruistic towards agents that are altruistic in return, this model follows Levine (1998). Two differences from his specification are worth highlighting. The first is that he considers a model where agent 1's altruism level becomes common knowledge in equilibrium, rather than remaining random. The second is that his model is one where agent 2's altruism responds smoothly to the level of agent 1's altruism. Here, instead, I suppose that the response is discontinuous. I do this for two reasons, one relatively general and the other specific to my application. In general, it appears that people's response to what they perceive to be ill treatment often moves almost seamlessly from passive acceptance to violent outburst. In the context of industrial relations, for example, worker unhappiness sometimes erupts in sudden strikes. In the case of road rage, some drivers react with unusual force to what they see as inconsiderate driving by others.[5] In the context of pricing, firms that raise their prices by small amounts often encounter no reduction in sales while larger price increases sometimes generate substantial resistance, including the threat of political intervention. This too might be rationalized in other ways. However, it seems natural to model this reaction as one of consumers who feel that the firm has "crossed the line".

Before discussing pricing in more detail, I consider how people with these preferences ought to behave in some classic experimental settings. The aim is to show that these preferences can account for the contrasting outcomes in "ultimatum" and "market" experiments reported in Roth et al (1991). In the former, equilibrium outcomes are often "fair" while in the latter, they are often lopsided. Fehr and Schmidt (1999) and Bolton and Ockenfels (2000) provide preferences that are meant to rationalize these outcomes, and it might be

[5] While I suppose that these violent reactions are the result of a drastic changes in attitude, they may instead be due to the fact that the person who is reacting is incapable of milder reactions.

thought on this basis that these preferences are also the best starting point for studying fair prices. Some of the benefits of using preferences based on intentions are discussed in the introduction. It turns out that, in addition, these preferences also have advantages for explaining the experimental evidence, and I discuss these advantages presently.

The well known "ultimatum game" involves a "proposer" who offers a "responder" an amount of money between 0 and a set sum A. If the responder rejects this offer both players get nothing. If he accepts it, the responder gets the amount offered while the proposer gets the difference between A and the the amount paid to the responder. Standard game-theoretic reasoning would predict that the responder receives a negligible positive offer and accepts. In practice, small offers are often rejected and most offers are substantial. Forsythe at al (1994) report that over half the participants in their experiments offer $A/2$.

Fehr and Schmidt (1999) suppose that, when paired with agent 2, agent 1 maximizes

$$x_1 - \alpha \max(0, x_2 - x_1) - \beta \max(0, x_1 - x_2)$$

and analogously for agent 2, where x_i is the level of resources in the hands of agent i while α and β are positive parameters. Bolton and Ockenfels (2000) consider a slightly different utility function that also imposes a penalty for differences between x_1 and x_2. It follows from maximizing this that, as a responder, agent 1 always accepts offers just below $A/2$. This means that that offers of $A/2$ are not motivated by the fear of having the responder turn them down. Instead, they are due to having the proposer have a β equal to at least 1/2. The case of $\beta = 1/2$ is a knife edge case in which the proposer is indifferent among many offers. To obtain offers of $A/2$ in a robust manner, β must actually exceed 1/2. This means that, when 2 has lower resources than 1, agent 1 must get more marginal utility from additional resources in agent 2's hands than from additional resources in his own.

Such a high level of regard for another's resources (at the margin) is implausible, particularly in settings where the person one is interacting with is not one that is seen as deserving of charity. Moreover, this level of regard has a readily refutable implication. Agents who offer $A/2$ in ultimatum games because $\beta > 1/2$ ought also to offer $A/2$ in the related "dictator" game. In this game, the proposer's offer is binding on the respondent who has no choice but to accept. While this change in specification ought to have no effect on proposers whose β exceeds 1/2, the fraction of proposers that offer $A/2$ in dictator games is dramatically smaller than the fraction that does so in ultimatum games. In Forsythe et al.'s (1994) experiments, the former equals about 20%.

Now consider how two agents with preferences given by (2) ought to play the ultimatum game. To simplify, I suppose that material payoffs are linear in the resources received so that U_i is equal to x_i while $x_1 + x_2$ remains equal to A. By making an offer, agent 1 essentially provides a signal of his altruism parameter λ_1. Proponents whose value of λ is relatively low may decide to make smaller offers even if this reveals that their benevolence is smaller. Suppose, in particular, that a particular offer reveals that the proposer's λ is no larger than $\hat{\lambda}$. Faced with this revelation, those respondents for which $\bar{\lambda} > \hat{\lambda}$ will turn down this offer. I suppose that $\bar{\lambda}$ is randomly distributed among potential respondents so that different people demand a different level of benevolence from those they interact with in this game. This means that, for each offer y, there is a probability that it will be accepted $G(y)$, which depends on the relationship between y and λ. For an arbitrary $G(y)$, a proposer's payoff is:

$$W_p = G(y)(A - (1 - \lambda_1)y)$$

If $G(y)$ is differentiable at a point, proposers ought to satisfy

$$-G(y)(1 - \lambda_1) + G'(y)(A - (1 - \lambda_1)y) = 0 \tag{3}$$

where primes denote derivatives. It follows immediately that, except at the y offered by proposers with $\lambda_1 = 1$, $G(y)$ must be strictly increasing for any offer that is actually made. Otherwise, with $\lambda_1 < 1$, proposers are better off with lower values of y.

The second derivative of W_p with respect to y is, $-2(1-\lambda_1)G' + G''(A-(1-\lambda_1)y)$. Since $G' > 0$, the second order conditions are satisfied as long as G'' is not too large. And, since the derivative of the left hand side of (3) with respect to λ_1 is positive, it follows that y must rise monotonically with λ_1 whenever G is differentiable and the second order conditions are satisfied. This, in turn, imposes a condition on $H(\bar{\lambda})$, the pdf of $\bar{\lambda}$. The reason it does so is that, if y is a monotonic function of λ_1, the responder can determine the value of λ_1 so that $G(y(\lambda_1)) = H(\lambda_1)$ where $y(\lambda_1)$ represents the offer associated with the level of altruism λ_1. Differentiating this and (3),

$$H' = G' \frac{G + G'y}{2(1-\lambda_1)G' + G''(A - (1-\lambda_1)y)}$$

It should be noted that not all equilibria of this game are fully separating so that each y does not need to be associated with a single λ_1. It seems particularly plausible to impose the condition that respondents never punish proposers who offer them $A/2$. One psychological motive for this may be that, even though responders secure high offers because they threaten to reject lower ones, they do not want to think of themselves as wielding this weapon so forcefully that they exploit the proposers. These qualms may lead them to abstain from turning down offers that equal at least $A/2$.

This would imply that $G(y)$ is not differentiable to the right of $A/2$. If $G(y)$ is only differentiable to the left of a point, an optimizing proposer may keep his y equal to those of individuals whose values of λ_1 are lower even if the left hand side of (3) is strictly positive when evaluated at the left derivative of $G(y)$. Similarly, consider the case where $G(y)$ only has a right derivative, which could occur at a level of offers sufficiently low that lower offers are always rejected. If the left hand side of (3) is negative when using the right derivative, it may be optimal for proposers to offer the same y as proposers whose λ_1 is larger.

To see an example of a partially pooling equilibrium of this kind, suppose that

$$G(y) = a + by \tag{4}$$

To ensure that $G(A/2)$ equals 1, I let $a = 1 - \frac{bA}{2}$. The first order condition (3) then gives

$$y = \frac{A}{2(1-\lambda_1)} - \frac{1}{2b} + \frac{A}{4} \tag{5}$$

This equation can be solved for the level of λ_1 such that the offer of $A/2$ satisfies the proposer's first order condition. This is

$$\lambda_1^* = \frac{2 - bA}{2 + bA} \tag{6}$$

Consider first the case where $bA < 2$ so that λ_1^* is strictly between zero and one. All proposers with a λ_1 above λ_1^* then offer $A/2$. Thus, even if λ_1 has a continuous distribution, a mass of them may pool at $A/2$ as is observed in the experimental data. These proposers make a generous offer even if their λ_1 is well short of 1 because they want to distinguish themselves from proposers whose λ_1 is lower still. What sustains high offers is that lower offers change the perception of the proposer's intentions, and some respondents react to small differences in intent. What is somewhat surprising is that this result obtains even though the total response is quite modest, and indeed the reduction in the probability of acceptance is arbitrarily small for sufficiently small reductions in offers.

Proposers whose λ_1 is below λ_1^* make somewhat lower offers, and the responses to these offers trace out $G(y)$. Indeed, using (5), one can reinterpret the probability that y is accepted as the probability that λ is acceptable. Thus,

$$H(\lambda) = G(y(\lambda)) = \frac{1 - bA}{4} + \frac{bA}{2(1 - \lambda)} \tag{7}$$

This function can only be valid for $\lambda \leq \lambda_1^*$ since $H(\lambda) = 1$ at this point. Because $bA < 2$, the constant a is positive and this represents the probability that offers of $y = 0$ are accepted. It is easy to change the specification slightly so that such offers cease to be accepted. Suppose, in particular, that (4) holds only for y above some minimum value $\hat{y}$ and that, lower offers are always rejected. Equation (5) can then be used to compute the value of λ_1, $\hat{\lambda}$, such that proposers satisfy the first order condition when they offer $\hat{y}$. Proposers with lower values of λ_1 then continue to offer $\hat{y}$ in spite of the fact that the left hand side of (3) is negative at this point because the welfare of doing so is obviously larger than that of making lower offers. For $G(y)$ to exhibit this discontinuity, at $\hat{\lambda}$, the probability H must satisfy (7) only for $\lambda \geq \hat{\lambda}$ while it must be zero for $\lambda < \hat{\lambda}$.

When $bA > 2$, λ_1^* is negative, which means that all proposers with positive λ_1 prefer offering $A/2$ to any lower offer. This implies that the function $G(y)$ is not traced out in equilibrium, however, so this case is somewhat less interesting. It does serve to reinforce the idea that, as long as they are sufficiently steep, differentiable $G(y)$'s are sufficient to keep proposers eager to show their good intentions by making high offers.

Before discussing other experimental games, it is worth discussing the relationship of these equilibria to those in Levine (1998) to whom the analysis owes both the result that proposers make high offers to signal their intentions and the method of starting with an empirical probability that offers will be accepted and then deriving underlying preference parameters. One difference between the two analyses is that, by extending the model to a setting with a continuum of possible values of λ_1, I was able to show why there could be partial pooling at relatively high offers. There are also two differences in the models' details. The first is that Levine (1998) supposes that an agent's altruism is linear in his perception of the other agent's altruism as opposed to be discontinuous as in my setting. The second is he does not make agents differ in the amount of altruism they require of others, they differ only in their own altruism. This combination of assumptions means that he can rationalize offers in observed ultimatum games only if the majority of the agents in his model have "negative regard" towards others.[6] To ensure that respondents turn down modest offers in his setting, most of these respondents must prefer worse outcomes for the proponents even if this requires that respondents suffer a small loss. By contrast, in my setup, every agent starts out expecting other agents' altruism to be such that they have a positive regard for them. Moreover, since the experimental evidence shows that the majority of offers is accepted, my model implies that, *ex post*, most agents have a positive regard for each other.

In its pure form, proposers in the dictator game cannot be penalized for making small offers. This means that, with material payoffs that are linear in income, my model thus predicts that dictators give nothing. In settings where receivers are anonymous, this is by far the most common offer (Burnham 2003). In the original Forsythe et al (1994) setting, proponents and respondents were students at the same university and were placed in communicating rooms. It is thus more reasonable to think of this setting as one where penalties

[6]In Levine (1998)'s model, agent 1's regard for agent 2 (*i.e.* the extent to which his own welfare increases with 2's material payoffs) equals $a_1+\lambda a_2$. He supposes that the parameters a_1 and a_2 take take three possible values and shows that they can be positive only with a .28 probability to account for the experimental data. I have also used his values of λ and a variety of the a's that satisfy his requirements to compute the expected values of $a_1 + \lambda a_2$ for each of his types. These too were positive only with a .28 probability.

for making low offers were not eliminated altogether even though they were reduced relative to those of the ultimatum game. To model these penalties adequately would takes us well beyond the scope of this paper. It is worth noting, however, that the model presented here is one where reductions in penalties for low offers can easily lead to less generous offers.

To see this, note that a reduction in b in equation (4) constitutes a reduction in penalties because the probability of having one's offer rejected falls less rapidly when y is reduced. If the constant a is adjusted to make sure that the probability of acceptance remains constant at $A/2$, (6) implies that the corresponding value of λ_1^* increases. This means that the range of proposers whose offer equals $A/2$ falls. In other words, this signaling game has the intuitive property that the generosity of offers falls when there is a reduction in the payoff from demonstrating that one's altruism is high. This seems broadly consistent with the reduction in large offers in the dictator relative to the ultimatum game.

Before closing this section, it is worth mentioning briefly the other experimental game considered by Roth et al (1991). This is a game where several buyers who each value a good at v make offers to a seller who has one unit to sell. The seller then decides which, if any, of these offers to accept. Observed outcomes in this game match closely those predicted by perfect equilibria in that the sellers get paid almost v. This outcome is also consistent with the preferences I propose. The reason is the following. Since buyers expect sellers to have values of λ_1 that are smaller than one, they would expect sellers to pick the highest offer. Now suppose that a buyer expects the highest offer made by other buyers to be v', which is less than v. By making an offer v'' between v and v', the buyer gains $(v - v'') - \lambda_2^b(v - v') + \lambda_2^s(v'' - v')$, where λ_2^b is the buyer's altruism for other buyers and λ_2^s is the buyer's altruism for the seller. As long as these two altruism parameters are less than 1, one can always find a v'' close to v' such that the buyer is better off making this offer. Thus, buyers compete in the usual way and the equilibrium offer is arbitrarily close to v. Note that, in this case, the potential reciprocity of other agents plays no role, and I have thus focused only on the effects of the altruism of the agents.

2 Pricing in a one period-model

I now start my analysis of pricing by considering a setting where agent 1 represents a firm that sells a product to consumers. There is only one period and the firm sets a price p at the beginning of the period. On the basis of this price consumers determine their level of desired purchases q. After this level of purchases is determined, the firm produces these unit at constant marginal cost c and sells them to the consumers. The firm's material payoffs are thus $(p - c)q$.

It might seem more natural to have the firm produce in advance of the realization of demand, and I consider this case below. An obvious consequence of this alternative assumption is that the firm may then produce goods that are not sold. In the one-period context, one would have to treat the cost of these goods as a loss to the firms. In a multi-period context, instead, these goods would be valuable additions to inventory. Indeed, one can interpret the timing assumption in this section as saying that goods that are unsold are worth c to the firm (so that nothing is lost from having produced more than the quantity demanded).

There is a unit mass of consumers who potentially buy the good, and their preferences have the form given by (2). The material payoffs of consumers are given by

$$U(q) + (I - pq) \tag{8}$$

where I is the individual's income. Letting these payoffs be linear in income simplifies the analysis. To simplify further I neglect any altruism from the consumers to the firms, though I maintain the assumption that consumers want to harm the other agent (here the firm selling the product) if the other agent's altruism is insufficient. Thus, each consumer maximizes

$$U(q) + (I - pq) - \xi(\hat{\lambda}, \bar{\lambda})(pq - cq + \bar{\pi})$$

where $\hat{\lambda}$ represents the vector of statistics about the firm's altruism parameter λ that is available each consumer while $\bar{\pi}$ represents the firms material payoffs from the sales to other consumers. For each unit that a consumer refrains from buying, the firm loses $p - c$ while the consumer loses $U' - p$. If U' is bounded, the consumer thus stops buying the good if ξ

is sufficiently large when the consumer can reject the hypothesis that $\lambda \geq \bar{\lambda}$. I assume these conditions are met so that anger leads to a complete cessation of purchases.

In practice, consumers who are upset at firms also complain loudly, and it seems likely that this is unpleasant for firm owners. In addition, angry consumers can mobilize politicians against firms, and it seems likely that this is costly to firms even leaving aside the possibility that regulations could be enacted that make firms worse off. Because it is not entirely clear how these other costs should be modelled I leave them aside and focus on the loss of customers. In some cases this is the empirically relevant outcome, as in the example I gave in the introduction where the picketing of a store by an angry consumer drove away other consumers. In others, alternate expressions of anger are more relevant because the good is sufficiently essential to consumers that ξ is not large enough to lead to a cessation of purchases. For these cases, my analysis of what happens when consumers stop purchasing should be thought of as an approximation to the case where consumer anger leads to other costs for producers.

The result of these assumption is that, if a consumer is not angry, he sets $U'(q) = p$, which can be inverted to give the demand curve $q = d(p)$ where $d' = 1/U''$. A firm that sets a price p, thus has a probability $G(p)$ of selling $d(p)$. With the complementary probability $(1 - G(p))$, the firm makes neither gains nor losses. Firms thus maximize

$$W_f(p, c) = G(p)\Big[pd(p)(1-\lambda) + \lambda U(d(p)) - cd(p)\Big] \tag{9}$$

with respect to p. If this optimization has an interior solution, it must satisfy the first order condition

$$G(p)d'(p)\left\{p\left[1 - \frac{1-\lambda}{\epsilon}\right] - c\right\} + G'(p)[pd(p)(1-\lambda) + \lambda U(d(p)) - cd(p)] = 0 \tag{10}$$

where ϵ is the elasticity of demand.

With G' equal to zero, firms would set the expression in curly brackets equal to zero. I use the term "altruistic optimum" to denote the resulting price. Instead of being equal to marginal cost times $\epsilon/(\epsilon - 1)$, as is the case when the firm is selfish, this price equals marginal cost times $\epsilon/(\epsilon+\lambda-1)$. Not surprisingly, this means that a higher value of λ lowers this price. It is thus logical for consumers to view higher prices as less consistent with the hypothesis that $\lambda \geq \bar{\lambda}$, thereby suggesting that $G' \leq 0$. It is immediately apparent that, if $G' < 0$, the left hand side of (10) continues to decline in λ. Thus, if the second order conditions are satisfied, the price that solves (10) is declining in λ and this rationalizes having $G' \leq 0$.

If $G' \leq 0$, the left hand side of (10) is increasing in c. Thus, using the terminology of Athey (2001), the game between consumers and firms satisfies the single crossing property. In particular, for any monotone strategy of consumers (where these respond to higher prices both by reducing the quantity demanded and increasing the odds of ceasing their purchases, the firm's optimal optimal price is monotone in its "type", where types here are given by c and λ. Similarly, for any monotone strategy of firms (where price is increasing in c and falling in λ), consumers find it optimal to respond to higher prices by reducing $G(p)$. Athey's (2001) analysis thus implies that the game has an equilibrium in pure strategies where firms and consumers actions are weakly monotonic. I will also be concerned with studying whether equilibria exist where this monotonicity is strict.

When G' is strictly negative, the second order conditions imply that the price charged by the firm is below the altruistic optimum. The firm does this to increase the probability that it actually sells its product. Interestingly, this effect can in principle lead an altruistic firm to charge a price below c. While such a price makes $(p-c)q$ negative, the firm gains something through the difference between $U(q)$ and pq.

To gain further insights into the both the effect of G on prices and on the determinants of G, I consider some numerical exercises that are based on

$$U(q) = \frac{\epsilon q^{1-\frac{1}{\epsilon}}}{\epsilon - 1} \tag{11}$$

Using this in (10) leads, after some manipulation to

$$p = \frac{c}{\epsilon+\lambda-1}(\epsilon - 1 + \omega) \qquad\qquad \omega \equiv \frac{(\epsilon-1)G(p)}{(\epsilon-1)G(p) - PG'(p)} \tag{12}$$

so that the price equals the altruistic optimum when ω equals 1 and falls as ω falls. As long as ω does not fall too rapidly as p rises, this equation implies that p is a monotonically increasing function of c. This monotonicity turns out to be useful below because it makes it easier for consumers to draw inferences about a firm's cost and altruism from its price.

In the previous section, the proposer was uncertain whether his offer would be accepted because he was unsure about $\bar{\lambda}$. In a case where a proposer is confronting a single anonymous responder, this type of uncertainty seems quite plausible. In the present context of a firm selling to a market it seems less so. The reason is that there is little reason to think $\bar{\lambda}$ ought to change over time, so that the firm can use its previous experience with customers to learn this parameter. What is more, $\bar{\lambda}$ represents a social understanding of what firms seek to accomplish, and it seems reasonable to suppose that this understanding is shared by firms as well. I thus imagine that the firm's actual altruism parameter λ also equals $\bar{\lambda}$. This means that, when households start from the null hypothesis that $\lambda = \bar{\lambda}$, their null hypothesis is intrinsically reasonable. At the same time, this hypothesis is still worth testing even if one can expect the typical firm to have this level of altruism, as long as there is some danger that some will firms deviate by being more selfish.

What makes this testing problem hard is that one can expect households and firms to have asymmetric information about costs. The firm obviously knows these costs much better than consumers. On the other hand, consumers have no choice but to trust the little independent information they have themselves in evaluating the fairness of firms. Moreover, the firms own extensive knowledge about costs may make the firm unable to understand the use that consumers make of the little information that they do have. One way of capturing this is to suppose that consumers have a signal about costs and that the firm is not well informed about this signal. I thus let consumers observe a signal s which is given by

$$s = \log(c) + \theta \tag{13}$$

where c represents actual costs and where $\log(c)$ and θ are independent random variables. For ease of exposition, I denote their pdf's by F_c and F_θ respectively. For much of the analysis

I suppose that these variables are normal with means of μ_c and μ_θ and standard deviations of σ_c and σ_θ respectively. These normality assumptions imply that the distribution of $\log(c)$ conditional on observing s is also normal, with mean $\mu_c + \sigma_c^2(s - \mu_c - \mu_\theta)/(\sigma_c^2 + \sigma_\theta^2)$ and standard deviation $\sigma_c\sigma_\theta/(\sigma_c^2 + \sigma_\theta^2)^{.5}$.

The equilibrium allocation depends on the extent to which the firm is informed about θ. Higher order beliefs, including whether consumers know the extent to which the firm is informed about θ can matter as well. The simplest case, and thus the one with which I start, is one where the distributional parameters of F_θ are common knowledge but where the firm knows nothing about the actual realization of θ. I thus focus mostly on this case in this paper.

The firm's price can then depend only on its cost c and on its altruism parameter λ. If price is a monotone function of costs for a given λ, consumers can infer a firm's cost from a price observation for a given value of λ. I denote by $\kappa(p, \lambda)$ this implied level of costs. Consumers would then reject the null hypothesis that $\lambda \geq \bar{\lambda}$ if $\kappa(p, \bar{\lambda})$ was high relative to their conditional distribution of c. In particular, this hypothesis would be rejected if

$$\log(\kappa(p, \bar{\lambda})) > \mu_c + \frac{\sigma_c^2(s - \mu_c - \mu_\theta)}{\sigma_c^2 + \sigma_\theta^2} + \frac{\zeta\sigma_c\sigma_\theta}{(\sigma_c^2 + \sigma_\theta^2)^{.5}} \tag{14}$$

where ζ depends on the test's level of significance (or p value) γ.[7]

This means that the probability $G(p)$ is the probability that the inequality in (14) fails to hold. This probability depends on both p (through κ) and c itself (through the signal s). I thus denote it by $G(p, c)$. Substituting for s in (14),

$$G(p, c) = 1 - F_\theta\Big(\mu_\theta + \frac{\sigma_c^2 + \sigma_\theta^2}{\sigma_c^2}\log(\kappa(p, \bar{\lambda})) - \log(c) - \frac{\sigma_\theta^2}{\sigma_c^2}\mu_c - \zeta(\sigma_c^2 + \sigma_\theta^2)^{.5}\frac{\sigma_\theta}{\sigma_c}\Big) \tag{15}$$

I look for a separating equilibrium where $\lambda = \bar{\lambda}$ and p reveals c so that $\kappa(p, \bar{\lambda})$ is equal to the level of costs c that leads to this particular p, which can be denoted by $c(p)$. The

[7] I adopt a "classical" approach to this testing problem because it avoids the need to specify a subjective distribution for λ. Consumers start instead by giving firms the benefit of the doubt. It is worth noting, however, that the classical one-sided test that I consider can be reconciled with a Bayesian one for suitable prior distributions for λ. See Casella and Berger (1987) for a discussion.

probability that consumers do not get upset by the firm's price is then

$$G(p, c(p)) = 1 - F_\theta\Big(\mu_\theta + \frac{\sigma_\theta^2}{\sigma_c^2}(\log(c(p)) - \mu_c) - \zeta(\sigma_c^2 + \sigma_\theta^2)^{.5}\frac{\sigma_\theta}{\sigma_c}\Big) \tag{16}$$

Note that, in equilibrium, this can be written as a function of c only since it depends on p only because p reveals c. The first order condition (10) involves a firm that considers changing its price for a given cost level. Such a change affects κ without affecting c. Thus, G' in (10) and (12) equals the derivative of $G(p, c)$ in (15) with respect to its first argument. Moreover, in a separating equilibrium consumers expect the firm's price to satisfy $c = c(p)$ so that the derivative of κ with respect to price, κ' equals c'. Thus, differentiating (15).

$$G'(p) = -F'_\theta \frac{\sigma_c^2 + \sigma_\theta^2}{\sigma_c^2}\frac{c'(p)}{c(p)} \tag{17}$$

where F'_θ is evaluated at the same point as F_θ in (16). Once again, this point only depends on c at a separating equilibrium. As a result, ω in (12) can be written as

$$\omega = \frac{(\epsilon - 1)G(p)}{(\epsilon - 1)G(p) - F'_\theta}\frac{\sigma_c^2 + \sigma_\theta^2}{\sigma_c^2}\frac{pc'(p)}{c(p)} \tag{18}$$

where all the terms except for $pc'(p)$ can be written exclusively as a function of c. When used in (12) this gives a differential equation linking the level of p to the level of c as well as the derivative of c with respect to p.

One qualitative feature of the solution to this equation which serves as an initial condition is that, for sufficiently low c, the price is arbitrarily close to the altruistic optimum. This occurs because $G(p)$ in (16) is arbitrarily close to 1 for low enough c. To understand this intuitively, note first that while a reduction in $\log(c)$ lowers the signal s one for one, it lowers the estimate of $\log(c)$ that consumers derive from this s by less than one for one. The reason is that, since consumers observe costs with noise, they attribute some of the decline in s to the noise component. This means that, for sufficiently low c, consumers must necessarily have an exaggerated estimate of firm costs so the firm does not need to be afraid of consumer anger. Or, put differently, a very extreme low value of θ is needed for consumers to reject the hypothesis that $\lambda \geq \bar{\lambda}$. By the same token, the density F'_θ at such low values is extremely low. Thus, assuming c' is bounded, ω is arbitrarily close to one. But, with ω close to 1, the firm charges a price close to the altruistic optimum, which ensures that c' is indeed bounded.

I denote the optimal one-period price that solves this problem by $p_1(c)$, where this is just the inverse of the function $c(p)$. The discussion above implies that $G(p_1(c)) < 1$ for high values of c because such values typically lead the consumer to underestimate c and thus make the consumer prone to anger. However, this does not lower prices as much as might be expected. In particular, ω in (12) does not fall monotonically as p rises. The reason is that, even though the probability that θ is below the critical value in (16) is very large (because θ would have to be very large for consumers to accept the hypothesis that $\lambda \geq \bar{\lambda}$) the density of θ is low at this point. Put differently, while the probability that consumers will find the firm's price too high is large when the firm has high costs, high costs also imply that this probability does not fall significantly when the firm cuts its price. Thus, the firm may charge a price close to the altruistic optimum also for high values of c.

Figure 1 plots $p_1(c)$ for the parameters $\mu_c = \mu_\theta = 0$, $\sigma_c = \sigma_\theta = 1$, $\epsilon = 2$, $\zeta = 1.8$ and $\lambda = \bar{\lambda} = .1$.[8] The Figure shows that, for these parameters, there does indeed exist a solution in which p is monotonically increasing in c so that consumers can easily recover $\kappa(p, \bar{\lambda})$. As the Figure shows, the resulting price is barely distinguishable from the altruistic optimum, though the two are not identical. While ω initially falls with c, it reaches a minimum of about .88 when c equals about 7.7. Beyond this point, ω rises once again so that the price starts getting closer to the altruistic optimum once more.

Thus, at least for these parameters, what really matters for prices is the firm's altruism itself. The threat that customers will react to prices that they deem unfair is less important, though it obviously would matter more to firms that are more selfish. These results can be contrasted with those I obtained for the ultimatum game with a rather similar model

[8] To obtain this numerical solution, I considered a grid for $\log(c)$ and iterated over vectors that gave the values of ω at each point in the grid. For each ω, (12) gives the price for each c. Having obtained these prices at a particular iteration, I fitted a cubic polynomial in c to these prices. I then used the derivatives of this polynomial to obtain c' at each point in the grid, and thereby computed the next set of values for ω using (18). The resulting solutions were always consistent with the required initial condition and were less sensitive to numerical error than those computed more directly from the initial condition itself.

of preferences. In that game, altruism alone does not lead to substantial offers unless the altruism parameter is unreasonably large. High offers are due, instead, to proposers wanting to prove that their own altruism parameter was not low. One reason for the reaction of customers to be less important in my model of pricing is that asymmetric information about costs makes price a less potent signal about altruism. Thus, while a firm that contemplates charging a different price realizes that this will affect the extent to which it is perceived as being properly altruistic, this effect is relatively small because customers realize that prices depend on cost and that their information about costs is poor. By contrast, in the ultimatum game with linear utility, the only source of differences in transfers is the extent of altruism so that the transfer provides a more powerful signal of altruism.

3 Firm information about the consumers' signal

The analysis so far has assumed that firms know relatively little about the information available to consumers. One obvious question that arises is then whether the result that consumer reactions play a relatively small role in pricing would be overturned if firms had better information about the signal available to consumers. It would seem that, if they did, firms might choose prices that are heavily influenced by this signal, something that would never occur under altruism alone. There is, however, a countervailing force. This is that a consumer that knows that a firm is informed about his signal and sees the firm departing from the signal may be led to infer that the firm has good reasons for doing so. This could allow altruism to be a central determinant of pricing once again.

An in depth analysis of the effect of firm information about household signals is beyond the scope of this paper. I do, however, consider a particular simple case in this section. I suppose, in particular, that the signal s in (13) is common knowledge. An immediate consequence of this assumption is that there cannot be a pure strategy equilibrium that induces complete separation *i.e.* one where firms all reveal their costs through their price. The reason is the following. If households use a pure strategy, it must take the form of buying $d(p)$ from all firms whose price is below a cutoff price $p^s(s)$ and not buying otherwise.

Knowing this, all firms for whom

$$p^s(s)\left(1-\frac{1-\lambda}{\epsilon}\right) \leq c \leq p^s(s)\left(1+\frac{\lambda}{\epsilon-1}\right)$$

or

$$r^- \equiv \log\left(1-\frac{1-\lambda}{\epsilon}\right) \leq s-\log(p^s(s))-\theta \leq \log\left(1+\frac{\lambda}{\epsilon-1}\right) \equiv r^+ \tag{19}$$

would charge $p^s(s)$. The reason they do so is that firms that satisfy both inequalities get a positive W_f from charging $P^s(s)$, get a lower W_f from charging a lower price because their altruistic optimum is above $p^s(s)$, and get $W_f = 0$ from charging a higher price. Firms for whom the second inequality in (19) is violated get a level of $W_f < 0$ by charging $p^s(s)$ and thus charge a higher price even if it means the loss of all their customers. Firms for whom the first inequality inequality is violated obtain a higher W_f by charging the altruistic optimum.

The classical statistical test procedure I let households employ requires that they accept the hypothesis that $\lambda = \bar{\lambda}$ unless the sample they observe *i.e.* the price, is consistent with $\bar{\lambda}$ only with probability γ. This means that households expect to reject their null hypothesis with frequency γ. In the context of this section, this requires that firms charge a price above $p^s(s)$ with probability γ. This occurs whenever the right inequality of (19) is violated. Therefore,

$$F_\theta(s-\log(p^s(s))-r^+) = \gamma \tag{20}$$

This equation defines an equilibrium value of $p^s(s)$ which is increasing in s. This is an equilibrium because the null hypothesis is being rejected with the proper probability and firms are acting optimally given the households' decision rule.

Letting (20) define the equilibrium value of $p^s(s)$ and using (19), the probability that the firm charges $p^s(s)$ is then $F_\theta(s-\log(p^s(s))-r^-)-\gamma$. Supposing that $\epsilon = 2$ and $\bar{\lambda} = .1$, $r^- = \log(.55) = -.6$ while $r^+ = \log(1.1) = .095$. Thus, with $\gamma = .05$ and $\zeta = 1.65$, $s-\log(p^s(s)) = -1.745$ so the probability that the firm charges $p^s(s)$ is .076. If, instead, $\gamma = .01$ and $\zeta = 2.33$, the probability that the firm charges $p^s(s)$ is only .024. Thus, while it is true that the firm is sometimes led to a price that depends on the household's signal, this occurs rather infrequently. The bulk of the time, the firm charges the price dictated by its own altruism and this is more generous than the minimum that households require.

This analysis does not rule out other equilibria. One sort of equilibrium that can be constructed has households also stopping their purchases from firms that charge *less* than a cutoff price p^s. If firms expect this behavior, then even firms with with costs below $p^s(1-\frac{1-\lambda}{\epsilon})$ will charge p^s. By doing so they receive $W_f > 0$, whereas they would get $W_f = 0$ if they deviated. However, an equilibrium where firms are punished for having prices that are too low is not reasonable. Indeed, it can be ruled out by the Cho and Kreps (1987) intuitive criterion or by deletion of dominated strategies.

4 The Fairness of Differences in Prices Paid by Different Customers

The basic premise of my model is that consumers react with anger to prices that are excessive. Price discrimination across different buyers as well as the related practice of putting items "on special" for short periods of time might be seen as inconsistent with this premise since they imply that some customers visibly pay more for a product than others. One might thus imagine that the customers who know they are paying a higher price get angry at the producer. Comparing the price one pays to the price charged to other customer either currently or in the recent past is probably easier for most customers than comparing price to cost. Households ought thus to make these comparisons regularly and one might imagine that this would dampen these price differences.

It should be pointed out, however, that the benevolence that customers require in my model does allow firms to care more for their own profits than for other's welfare. Thus, the reasons that have been given for price differences in the literature based on profit maximization could easily remain relevant in situations where firms are also concerned with consumer welfare directly. Interestingly, benevolence is consistent with these pricing practices also in a stronger sense. Benevolence, by itself, can also be a source of both third degree and intertemporal price discrimination. In other words, altruistic firms have reasons to engage in these forms of pricing in situations where selfish firms do not. This by no means establishes that the reason we observe these practices is because firms are concerned with being seen as fair. It does, however, show that models based on firm altruism also have the potential for explaining pricing practices that may at first appear inconsistent with ”fair pricing”.

To make this point, I temporarily neglect customer reactions against firms that are not sufficiently altruistic. I do this for two reasons. The first is that, once it is recognized that altruistic firms ought to charge different prices, customers that want their suppliers to be altruistic will actually prefer to deal with firms whose prices vary from customer to customer. The second is that, as we saw above, the equilibrium price is often quite close to the altruistic optimum.

4.1 Third-degree price discrimination

One commonly observed form of price discrimination involves charging different amounts to individuals whose visible characteristics differ. Among these practices, discounts to the young, to the elderly and to students seem particularly ubiquitous. I thus consider two types of customers and let their material payoffs be

$$V(U(q_i) + I_i - p_i q_i) \qquad\qquad i = 1, 2.$$

I have chosen this specification of preferences because it implies that, in the absence of any fairness considerations, all consumers set $U'(q)$ equal to p so that they buy the same quantity for a given price. This means all purchasers have the same elasticity of demand ϵ and a profit-maximizing firm gains nothing from third-degree price discrimination.

Now consider a firm that has an altruism parameter λ for all its customers. It maximizes

$$\sum_i [(p_i - c)q_i + \lambda(V(U(q_i) + I_i - p_i q_i))]$$

Using the relationship $U' = p$, the first order condition for this problem can be rearranged to yield

$$P_i \left(1 - \frac{1 - \lambda V_i'}{\epsilon}\right) = c \tag{21}$$

This means that differences in V' ought to translate into different prices. In particular, consumers whose marginal utility of income is higher have higher V's and should thus be charged lower prices. This may explain why discounts are often offered to groups that are generally perceived to be relatively poor. That such discounts can be perceived as fair is confirmed by the open-ended interviews reported by Maxwell (1995). While some of her respondents felt that charging different prices to different customers was unfair, many more thought that fair price ought to be affordable to everyone so that senior citizens ought to pay less "because they're on fixed incomes and that is all they can afford" (p. 25). This is a type of fairness where rewards are seen as fair if they are responsive to differences in need.

This result obviously hinges on cardinal representations of utility that allow firms to compare the marginal utility of income of different agents. This comparability makes sense if altruism is thought of as being the result of "putting oneself in someone else's shoes" to empathize with their plight. This naturally leads altruists to feel that different potential recipients of their largesse benefit to different extents from the same additional resources.

Interestingly, the third-degree discrimination result in this section does not require that customers themselves feel altruism for one another. The high paying customers need not feel altruistic towards the low-paying ones. Even though only the firm is altruistic, the high paying customer can, under the assumptions above, understand why the low-paying customer receives a better deal. They are thus unable to complain about lack of altruism on the firm's part.

4.2 Putting items "on special"

As discussed both in Rotemberg (2002) and below, one reason to consider customers who want their suppliers to be altruistic is to rationalize the rigidity of pricing. But, while "regular" prices for many products are quite rigid, the price paid varies as items are put on and off special. This raises two related questions. The most general is whether these kinds of price changes differ from regular price changes. The more specific one is why customers would find it acceptable to have prices vary when items are put on special but feel betrayed when regular prices change. The reason I give in this section is that an altruistic firm may make excessive losses if it charges the "special" price every period while it makes gains that are seen as excessive if it always charges a high price. In situations where intermediate prices do not make much sense because demand is bimodal, charging a low price some fraction of the time provides a way to avoid both these difficulties.

The model I use has many of the elements in Pesendorfer (2002), who in turn builds on an extensive prior literature that he cites. I suppose, in particular that some customers have a high valuation v_2 for a good while others have a lower valuation v_1. Unlike Pesendorfer (2002), I let the number of individuals with valuation v_i be constant over time and equal to N_i. This eliminates the source of "specials" in his model, which is based on the idea that high valuation consumers exit the market after purchasing goods at high prices and thereby raise the elasticity of demand in the next period (because the market then includes a higher fraction of low-valuation consumers). In the supermarket context where many specials are observed, my assumption is somewhat appealing if one thinks of high valuation customers as buying only for instantaneous consumption.

In period t, the firm charges a price p_t and sells quantity q_t. Thus, variable profits in each period are $(p_t - c)q_t$. Critical to my finding of price variations is the idea that the firm loses a great deal if its profits are low on average while it gains relatively little by having high profits in each period. The losses when profits are consistently low can be thought of as the cost of dissolving the firm to meet the demands of its creditors. The firm might, for example, have a fixed cost F and might suffer greatly if its cash on hand is insufficient to pay out F but gain relatively little if its available funds are larger than F. Thus, as long as the firm makes profits larger than F in some periods, it can afford to make profits lower than F in others. Rather than keeping track of the firm's funds in each period, which seems relatively cumbersome, I capture the firm's attitude towards profits by supposing that the firm's material payoffs are given by

$$U_f(E((p - c)q - F))$$

where the expectations operator here takes averages over different points in time and U_f is a concave increasing function.

Given that U_f is monotone, the firm strictly prefers a price of v_2 to any price between v_1 and v_2 since that raises revenue without changing costs. The per period profit from charging v_2 rather than v_1 equals Δ where

$$\Delta = (v_2 - v_1)N_2 - (v_1 - c)N_1 \tag{22}$$

The advantage of charging the high price is that N_2 customers pay more while the disadvantage is that the firm foregoes the profit $v_1 - c$ on the N_1 low-valuation customers. I suppose that $\Delta > 0$ so that the monotonicity of U_f implies that the firm would charge the constant price v_2 if it were selfish.

Now suppose that, the firm is also concerned with the average utility that its customers derive. In each period that the firm charges v_2, its customers obtain a surplus of zero. On the other hand, whenever it charges v_1, the high valuation customers gain $v_2 - v_1$, which yields the firm $\lambda(v_2 - v_1)N_2$ in additional utility.

By charging a price v_1 a fraction Φ of the time, the altruistic firm's total payoff is

$$U_f((v_2 - c)N_2 - \Phi\Delta) + \Phi\lambda(v_2 - v_1)$$

Because U_f is concave, it is possible simultaneously for

$$\Delta U_f'((v_2 - c)N_2) < \lambda(v_2 - v_1) \qquad \text{and} \qquad \Delta U_f'((v_2 - c)N_2 - \Delta) > \lambda(v_2 - v_1) \tag{23}$$

When (23) is satisfied, the optimum involves charging v_1 for a fraction Φ of the time where $0 < \Phi < 1$ and Φ solves the first order condition

$$-\Delta U_f'((v_2 - c)N_2 - \Phi\Delta) + \lambda(v_2 - v_1) = 0$$

Note that specials are much better for a partially altruistic and partially selfish firm than simply handing money to its customers. When a firm hands over money, its material losses are the same as the customer's material gains. By putting a good on special, the firm loses

Δ but, in the case where $v_1 > c$, this is less than the gain to the high valuation customers because the firm makes some profits from the low-valuation ones.

Since the next two sections are devoted to studying price rigidity, it is worth discussing how specials differ from prices that are flexible. The main differences seem to be that specials represent relatively large price reductions that are explicitly temporary and that involve the expectation that the price will rise again to its pre-special level. Moreover, insofar as specials are seen as having been programmed in advance, neither the initial price reduction due to specials nor the subsequent increase as prices come back to their "regular" level, are attributable to changes in either costs or demand. They are thus most easily interpreted as part of a program to charge different prices, as in the model discussed in this section. This means, in particular, that the price increase that end the period where the good is on special should not cause as much scrutiny of the firm's fairness as price increases that do not represent pre-announced returns to "old" prices. Price increases that cannot be justified in this way are the subject of the next two sections.

5 The Fairness of Raising Prices when Demand Rises

Survey evidence by Kahneman, Knetsch and Thaler (1986) shows that people regard it as unfair if a firm raises the prices of goods that suddenly becomes essential. In follow-on research, Maxwell (1995) shows that respondents are more likely to deem a price increase unfair if it coincides with a natural disaster. Even small price increases are seen as less acceptable when imposed in the context of a serious storm. Journalistic evidence suggests that the unhappiness with firms that raise prices in such circumstances, which is often referred to as gouging, often translates into active complaints. The L.A. Times of January 30, 1994, for example, reported that irate consumers threatened stores that raised prices after an earthquake with boycotts. Similarly, numerous State Attorney Generals responded to customer complaints by expressing vehement disapproval of gas stations that raised prices after September 11, 2001 and threatened them with lawsuits.

Kahneman, Knetsch and Thaler (1986) explain this phenomenon by positing that prices are fair when they satisfy two entitlements. These are the producer's entitlement to his reference level of profits and the consumer's entitlement to his reference price. Kahneman, Knetsch and Thaler (1986) further suggest that these reference levels are often historical ones, so that old prices serve to anchor current prices except when cost increases require that prices be increased for producers to maintain their old level of profits. At that point, according to Kahneman, Knetsch and Thaler (1986), the producer's entitlement becomes stronger than the consumers' one.

I now apply my model to a setting with random *ex post* demand fluctuations and ask when it implies that prices will remain rigid in the face of a large demand increase. The assumptions under which I obtain price rigidity are closely related to the "dual entitlement" view, so that the model serves as a partial formalization of the ideas in Kahneman, Knetsch and Thaler (1986). I show, for example, that when consumers' material payoffs depend only on their consumption, firm altruism is not sufficient to explain price rigidity except in the implausible case where the firm values income in the hands of its customers more than it values income in its own hands. If, instead, consumers also feel a direct loss in utility when the price they pay is higher price than the price that prevailed some time before, price rigidity emerges in equilibrium.

Probably the simplest reason for such a direct loss in utility is that consumers feel regret for not having made the purchase earlier. The resulting pain can then exceed the loss in *ex post* material payoffs. Increase in prices do, of course, reduce an individual's consumption relative to the consumption he could have enjoyed if prices had stayed constant. This loss in expected future material payoffs is the same regardless of whether the individual could have protected himself by buying the good in advance. The loss coming from regret, by contrast, arises only when the good could have been purchased earlier.[9] Thus, this model does not imply that prices ought to be constant when the increase in demand is due to a surge in *new* customers. When this occurs, as when visitors flock to Cannes during the film festival or

[9] See Bell (1982) as well as Tsiros and Mittal (2000) as well as the references cited therein for models, references and evidence.

to Frankfurt during the book fair, it is common, particularly for hotels, to raise their rates substantially.[10]

Once consumers suffer a direct loss in utility from price increases, an interesting result follows for an important class of demand functions. For these functions, small price increase are seen as less fair when demand rises a great deal than when it rises only modestly. This fits with the evidence in Maxwell (1995), but seems different in spirit from the premise of the Fehr and Schmidt (1999) model. In that model, agents want the gains from interactions to be equally divided. This would seem to suggest that an increase in the gains obtained from one party in the transaction (as is the case of purchasing snow shovels during a snowstorm) ought to allow the other party to make larger gains as well (so that the price ought to be allowed to rise).

The reason my result is possible is that, when demand increases, price increases improve the efficiency of the allocation *across consumers* and an altruistic firm ought to take this into account. The extent to which small price increases lead to this increased efficiency does generally depend on the disparity between current prices and market clearing prices. Consider, the special case of a good for which an increase in demand takes exclusively the form of an increase in the quantity of purchasers because each purchaser buys one unit. The role of price in such a setting is to assign the units to those who value them the most. Suppose, however, that the price is already much lower than the market clearing level, so that essentially everyone wishes to purchase a unit. Then, small increases in price have little effect on the quantity demanded and thus do not appreciably improve the allocation of the scarce good. Thus, an altruistic firm will see small price increases as less useful and is thus less likely to impose such increases.

To see this formally, suppose that the standard, material component of the utility of individual consumers is given by

$$V((\phi + a - p)x + I)$$

[10] See, "The big squeeze - Unfair fairs," *The Economist*, October, 18 2003.

where x equals 1 if the person buys the good and 0 otherwise, p is the good's price, ϕ is a parameter shifting the demand for all individuals and a is distributed across individuals with pdf $F(a)$ and support $[a_L, a_H]$. With n representing the total number of consumers, the number of consumers willing to buy the good at price p is $n(1 - F(p - \phi))$.

Now consider a firm that has produced q units in advance, and which cannot increase or reduce its sales volume in the short run. If it sets the price so that $n(1 - F(p - \phi))$ equals q, the market clears. If the price is lower, the good must be rationed. To ensure that the rationing that accompanies low prices is less effective at allocating goods than letting markets clear, I suppose that the recipients of the good when the price is set below the market clearing level are randomly drawn from those for whom $(\phi + a) \geq p$. This means that, taking expectations over realizations of a, an individual's expected material payoffs when the price is below the market clearing level are

$$\bar{U} = V(I)\left(1 - \frac{q}{n}\right) + \frac{q}{n}\tilde{U}$$

where

$$\tilde{U} = \frac{\int_{p-\phi}^{a_H} V(\phi + a - p + I)dF(a)}{1 - F(p - \phi)}$$

Recalling that sales q stay fixed because the price is below the level that ensures that only q is demanded, the derivative of total consumer welfare with respect to p is then

$$\frac{d\bar{U}}{dp} = \frac{-\int_{p-\phi}^{a_H} V'(\phi + a - p + I)dF(a) + [(\tilde{U} - V(I))F'(p - \phi)]}{(1 - F(p - \phi))n/q} \tag{24}$$

The term in square brackets captures the improvement in the allocation across consumers from raising the price. Such a price increase ensures that some buyers whose utility from obtaining the good is $V(I)$ are replaced by buyers whose average valuation is $\tilde{U}$, which is higher. The density of such replacements is $F'(p - \phi)$.

The material payoffs to the firm from selling q units at price p are $v(pq)$. Thus, an altruistic's firm's change in welfare when p changes is

$$qv' + \lambda n\frac{d\bar{U}}{dp}.$$

Letting V' be constant, and adding a term $-\lambda\ell$, which I discuss below, this reduces to

$$qv' - \lambda qV' + \lambda q \frac{F'(p-\phi)(\tilde{U} - V(I))}{1 - F(p-\phi)} - \lambda\ell \tag{25}$$

Under the reasonable supposition that $v' > \lambda V'$ so that the firm's altruism is limited, this is positive when $\ell = 0$ because $\tilde{U} > V(I)$. So, the firm is better off raising price away from the level at which consumers are rationed. Thus, an increase in ϕ would lead to an increase in price if the firm were able to change its price *ex post*. To rationalize price rigidity in the face of an increase in ϕ , there must be some other cost borne by consumers when prices are raised. If this cost is ℓ and the altruistic firm experiences the loss $\lambda\ell$ when it raises its price, the firm will prefer a constant price to a small price increase for ℓ sufficiently large.

It then becomes interesting to ask whether an altruistic firm has an increased incentive to raise price when ϕ rises by more. It follows immediately from (25) that the firm's incentive to raise its price slightly falls as ϕ increases as long as the increase in ϕ lowers sufficiently the density of individuals that are indifferent between buying and not buying at p. If, in particular, F has bounded support, there is always a ϕ large enough that the term in square brackets in (24) equals zero. For lower ϕ, this term is positive so that an increase in ϕ lowers the incentive to implement a small price increase in this case. Small price increases become less attractive because they no longer serve to improve the allocation. If there is a snow storm severe enough that everyone wants a snow shovel, a small increase in price does not help very much in getting the shovels to those who value them the most.

However, this begs the question of why the firm does not respond to a large change in ϕ with a large change in price. After all, once the price rises enough, it becomes effective once again at preventing those with relatively low valuation from buying the good. There are two reasons why large price increases may not be attractive either.

The first is that the firm's marginal utility of income falls as p rises, so that it could end up below the consumer's marginal utility of income V'. The second is that the psychological cost of facing a price increase ℓ could be increasing in the price. I consider these explanations briefly in the context where F is uniform between a_L and a_H. With this distribution of consumer valuations, all n consumers wish to buy if p is below $(\phi + a_L)$, while the quantity demanded equals $n(\phi + a_H - p)/(a_H - a_L)$ for prices above this level. Thus, if $q < n$, the market clearing price is $\phi + a_h - (a_h - a_L)q/n$. For prices below this, total consumer welfare is

$$V(I)(n-q) + q\frac{\int_{\max(a_L,p-\phi)}^{a_H} V(\phi + a - p + I)dF(a)}{(\phi + a_H - p)/(a_h - a_L)}$$

Assuming that V' is constant and setting $V(I) = 0$ for simplicity, total consumer welfare is then

$$qV'\left[\phi - p + \frac{a_H + a_L}{2}\right] \qquad \text{for} \qquad p < \phi + a_L$$

$$qV'\left[\frac{\phi - p + a_H}{2}\right] \qquad \text{for} \qquad p \geq \phi + a_L$$

These expressions make it clear how much faster consumer welfare declines as price goes up when all consumers are rationed because $p < (\phi + a_L)$. Now consider the desirability of raising the price away from p_0 when ϕ rises to a level such that p_0 is below the market clearing price. Total consumer welfare at any market clearing price is $q^2V'(a_H - a_L)/2n$. Thus, supposing that p_0 clears the market for $\phi = \phi_0$, the gain in consumer welfare from keeping the price at p_0 rather than moving it to the market clearing price for ϕ is given by $qV'(\phi - \phi_0)/2$ for $(\phi - \phi_0) < (a_H - a_L)(1 - q/n)$ and by $qV'(\phi - \phi_0 - (a_H - a_L)(1 - q/n)/2)$ otherwise. These losses are depicted in Figures 2 and 3. These figures are drawn for a_H, a_L, V', n and q equal to 10, 5, 1, 10 and 5 respectively. The figures also include two possible measures of producer gains from charging the market clearing price as opposed to p_0. These measures of producer gains are divided by λ so that altruistic producers prefer the market clearing price to keeping the price fixed only if the depicted gains exceed the depicted consumer losses.

Figure 2 shows a case where the gains v are extremely concave so that $v' < V'$ for large enough p. This, by itself, ensures that the firm prefers a rigid price to a sufficiently large p. The Figure shows that the region in which price remains rigid expands if there is a fixed cost like ℓ that consumers incur every time the price is changed. Figure 3 focuses on a case where $v' > V'$ so that producers are made better of when consumers transfer them resources. This means that, as ϕ increases, charging the market clearing price becomes ever more attractive to producers relative to the vicarious losses they experience from the losses in their consumer's standard of living.

The Figure also shows, however, that the situation can change if consumers' additional loss from price changes is linear in the size of the price change. In the case of consumer regret at not having bought at an earlier price, it seems reasonable to suppose that regret rises with the extent to which prices subsequently rose. This can lead to an outcome like that of Figure 3. With ℓ rising linearly as in the Figure, producers choose to charge the market clearing price when ϕ rises by a small amount. When, ϕ rises to a greater extent the producers prefer to keep prices constant to charging the market clearing level. In this case, small price increases are undesirable because they have little effect on the allocation. Larger ones do ensure that the scarce goods are allocated to those that value them most but they have the disadvantage of inducing enough regret that an altruistic producer prefers to let the goods be rationed randomly at the existing price. It is probably more plausible still to suppose that, while the costs ℓ rise with the size of the price change, there may also be a positive component of ℓ whose size is independent of the size of the price change. This could lead to prices being changed only when demand changes are intermediate in size while prices are kept fixed both for small and large changes in demand.

6 Price changes in response to cost movements

In the previous section I considered a setting where the firm produced output in advance and demand fluctuated *ex post*. This was motivated by what happens in relatively small localities over short periods of time. Since it takes time to ship goods to localities with big bursts in demand, these bursts can lead to shortages if prices are rigid. In practice, price rigidity is found in many other settings as well. In particular, price rigidity tends to be sufficiently long lasting that firms have time to adjust their production to meet the levels of demand induced by the prices they charge. The result is that units produced with different production costs are often sold at the same price. In this section, I thus consider price rigidity in the face of changes in cost conditions.

To keep the analysis simple, I continue to study a one-period model. The only difference with the model of Section 2 is that the firm inherits the price p_0 from the past. The focus of my analysis is then the set of conditions under which the firm prefers to charge p_0 rather than charging $p_1(c)$, so that the price remains rigid. There are two simple sources for price rigidity in this model. The first is the disappointment suffered by consumers when they see a higher price than in the past. As in the previous section, I suppose that this disappointment leads to a cost ℓ for consumers and a sympathy cost of $\lambda\ell$ for the firm.

A second source of price rigidity is that consumers may not reevaluate the fairness of firms whose price does not change. As discussed in Rotemberg (2002), there are several ways of rationalizing this selective inattention. For example, obtaining the current signal s may require that households expend a small cost and households may believe that there is a probability π that current costs and the current signal s are equal to their values in the past. For sufficiently large π, the cost of the signal is not worth incurring if the price is unchanged and the hypothesis that $\lambda \geq \bar{\lambda}$ is accepted in this case. By contrast, when the price changes, the household must learn the signal s to meaningfully test this hypothesis. This means that a firm that keeps its price unchanged receives W_f/G rather than W_f, since it is sure not to be punished by its customers.

I consider these two frictions in turn and compare the qualitative features of the ensuing price rigidity to those that emerge from supposing that producers have an administrative cost of changing prices, as in Barro (1972) and Sheshinski and Weiss (1977).

6.1 Price rigidity with customer disappointment at price increases

For any inherited price p_0, one can compute the cost $\tilde{c}(p_0) = p_1^{-1}(p_0)$ which would lead a firm to charge p_0 if the firm faced the one period problem I studied in section 2. It follows immediately from that analysis that there exists an equilibrium where the firm lowers its price to $p_1(c)$ whenever $c < \tilde{c}(p_0)$. If the equilibrium price reveals costs in this range, consumers compute the fairness of this price based on their signal as above. Thus, firms satisfy (10) and, for the functional form I focus on, (12).

Now consider the price $\hat{p} > p_0$, with associated cost $\hat{c} = c(\hat{p})$ such that

$$G(p_0, \hat{c})p_0^{-\epsilon}\left[p_0\left(1+\frac{\bar{\lambda}}{\epsilon-1}\right)-\hat{c}\right] = G(\hat{p}, \hat{c})\hat{p}^{-\epsilon}\left[\hat{p}\left(1+\frac{\bar{\lambda}}{\epsilon-1}\right)-\hat{c}\right]-\bar{\lambda}\ell \tag{26}$$

The left hand side of this expression is the welfare of an altruistic firm that continues to charge p_0 even though its cost is $\hat{c}$ while the right hand side is its welfare if it raises its price to $\hat{c}$ and, as a result, incurs the vicarious cost $\lambda\ell$. I now argue that, in equilibrium, firms with costs between $\tilde{c}$ and $\hat{c}$ do not reveal their cost through their price so that they all pool and charge the inherited price p_0. The reason is that, if a firm revealed its cost by having a higher price, consumers would know that an increase in its welfare would only be consistent with a $\lambda < \bar{\lambda}$. In other words, (26) implies that an altruistic form with $\lambda = \bar{\lambda}$ would prefer not to reveal its cost in this way. Note that, in doing this calculation, I suppose that consumers only reject $\lambda = \bar{\lambda}$ for a firm with constant prices if their signal implies that costs are even lower than $\tilde{c}$. This is reasonable because firms whose cost is equal to $\tilde{c}$ would charge this price even in a separating equilibrium.

Firms whose cost exceeds $\hat{c}$ are, according to (26) better off revealing this by charging $p_1(c)$ even if this lowers $G(p)$. Thus, it is consistent with equilibrium for these firms to charge the one-period price $p_1(c)$. It follows that, for any price p_0, there is another price $\hat{p}(p_0)$ such that the firm never changes its price from $\tilde{p}$ to a price between p_0 and $\hat{p}(p_0)$. The existence of a minimum size of price increases is obviously one form of price rigidity. Another is that prices do not move even if costs do, as long as costs stay within a certain zone of inaction. In particular, prices stay constant at p_0 for cost realizations between $\tilde{c}(p_0)$ and $\hat{c}(p_0)$.

It is worth comparing these minimum price changes and zones of inaction to the ones that emerges from a standard monopolistically competitive model with fixed administrative costs of changing prices. For this purpose, consider a firm whose demand is the result of the preferences in (11) so that its profits and optimal price in the absence of costs of changing prices are, respectively, $p^{-\epsilon}(p-c)$ and $\epsilon c/(\epsilon-1)$. Suppose again that the firm inherits p_0 but that it now has a cost of changing prices equals L. The equilibrium then involves two critical levels of costs, $\underline{c} < \bar{c}$ and two corresponding prices $\underline{p} = \epsilon\underline{c}/(\epsilon-1)$ and $\bar{p} = \epsilon\bar{c}/(\epsilon-1)$.

The firm keeps its prices equal to p_0 for costs between $\underline{c}$ and $\bar{c}$. For costs outside this range, the firm changes its price and charges the price that would be optimal for a single period. The prices $\underline{p}$ and $\bar{p}$ solve the equation

$$p_0^{-\epsilon}\left(p_0 - \frac{(\epsilon-1)\bar{p}}{\epsilon}\right) = \frac{\bar{p}^{1-\epsilon}}{\epsilon-1} - L \tag{27}$$

For low values of L, the two prices that solve this equation are essentially symmetric around p_0. This means that prices are rigid in the two senses I described. In particular, there is a mass of realizations for c such that the price stays constant even though costs do not. Second, price increases and price declines have minimum sizes, and these two are comparable in this case. While the case of psychological costs also induces a range of realizations with constant price, it implies instead that the minimum price decline is infinitesimal. One can also draw a contrast between the price increases implied by the two models.

Returning to the administrative cost model, let Δ be the smallest percentage price change in equilibrium, *i.e.* the percent difference between p_0 and the $\bar{p}$ that solves (27). This equation then implies that Δ is increasing in L and falling in $p_0^{1-\epsilon}$ and, indeed, that Δ would remain constant if L were proportional to $p_0^{1-\epsilon}$. This latter variable matters because a higher $p_0^{1-\epsilon}$ leads to higher profits for a given p_0/c so that any given percentage difference between the price and the optimum price involves a larger absolute loss of profits. This means that the gain in profits from adjusting price is higher relative to the cost L of doing so.

Over relative short spans of time, one would not expect big fluctuations in either the real value of L or the real value of p_0, which is proportional to the real value of the level of cost that led to the price that is currently being changed. The minimum size of price changes predicted by this model ought thus to be very stable. In practice, however, there are at least some contexts where price changes of rather different sizes are observed over relatively short periods of time. Carlton (1986) and Kashyap (1995) both observed small price (as well as large) price changes and saw this as a failure of the administrative cost model.

If the relevant cost is a psychological cost to consumers one can expect much more diversity in the size of the minimal price increase. To see this, Figure 4 draws the minimum increase in the log price $(\log(\hat{p}) - \log(p_0))$ as a function of the log of p_0 for the parameters underlying Figure 1. This Figure is drawn under the assumption that $\bar{\lambda}\ell$, the psychological costs experienced by the firm, equal $.0001p_0^{1-\epsilon}$. I used this dependence of the cost of changing prices on $p_0^{1-\epsilon}$ to abstract from the effect of the latter, which may well be unimportant in practice and which also affects price changes in the case of administrative costs. The Figure shows shows that the minimum change in prices increases with the base price when the costs are psychological and that the minimum change is negligible for small enough p_0.

The reason for this is that if the initial price is low and the firm is widely seen as fair, it has little to fear from customer anger when it increases prices slightly and, with a small ℓ, its smallest price change is thus modest. By contrast, when the firm is already charging a relatively high price, customers are likely to see it as unfair so that the firms has relatively little to gain from raising its price further. Its probability of having purchases continue, $G(p)$ is already low and it falls further if the price is increased. The firm therefore tends to keep its price constant even for relatively large increases in cost. Consumer retaliation thus plays a crucial role in pricing in the multiperiod context even though its role in the one-period problem of Figure 1 was fairly muted.

6.2 Price rigidity from consumer inattention

I now ignore the psychological cost ℓ and suppose simply that the probability of selling $d(p_0)$ equals 1 if the firm keeps its price constant at p_0. When the firm raises its price, consumers observe s and judge it as before. I consider two alternate scenarios for what happens when the firm lowers its price. In the first, consumers learn s once again. This is probably the logically most compelling case since the existence of a price change dissuades consumers that costs have remained constant and the consumer is thus forced to learn s if he wants to make a meaningful inference about λ. An alternative specification, on the other hand, would have the consumers buy $d(p)$ with probability 1 whenever the firm lowers its price below p_0. What is intuitively appealing about this specification is that it ensures that households do not become more prone to punish a firm just because it lowers its price.

Consider first this second case and let $\tilde{c}(p_0) = (1 - \frac{1-\lambda}{\epsilon})p_0$ so that this level of costs leads to the price p_o at the altruistic optimum. For any cost realization smaller than or equal to $\tilde{c}$, the firm charges the altruistic optimum since it is not afraid of customer reactions. This means that there is, once again, no minimum size for price declines.

To study price increases, consider the price $\hat{p}$ with associated cost $\hat{c} = c(\hat{p})$ such that

$$p_0^{-\epsilon}\left[p_0\left(1+\frac{\bar{\lambda}}{\epsilon-1}\right)-\hat{c}\right] = G(\hat{p},\hat{c})\left\{\hat{p}^{-\epsilon}\left[\hat{p}\left(1+\frac{\bar{\lambda}}{\epsilon-1}\right)-\hat{c}\right]\right\} \tag{28}$$

This equation has a solution for $\hat{c} > \tilde{c}$ because the left hand side is greater than the right hand side when $\tilde{c} = \hat{c}$ and $p_0 = \hat{p}$ while the left hand side declines as p_0 declines. For any cost realization greater than or equal to $\hat{c}$, the firm prefers to charge $p_1(c)$ to charging p_0 even though this reveals $\hat{c}$. Therefore the firm does so. Consider, by contrast, the firm's actions when costs are between $\tilde{c}$ and $\hat{c}$. Since G depends only on the cost level revealed by the price, the firm strictly prefers to charge p_0 to charging any price above p_0 if the latter reveals the firm's cost. Thus, the firm charges p_0. There is thus a mass of cost realizations for which price is constant and price increases cannot be smaller than a certain minimum size. Figure 5 displays the minimum increase $\log(\hat{p}(p_0)/p_0)$ as a function of $\log p_0$. This too shows that the minimum price change is negligible when p_0 is small while it rises dramatically when p_0 rises. The reason is that, for p_0 small, G essentially equals 1, so the firm is not punished for raising its price by a small amount. When p_0 is larger, by contrast, avoiding the consumer's potential punishment becomes a strong motivation for keeping one's price constant.

In closing, consider the case where price declines also trigger re-evaluation of the firm's fairness. This leads to an equilibrium which hinges on there being a solution to (28) for a $\hat{p}$ smaller than p_0. It turns out that such a solution, which I denote by $\hat{p}^{-}(p_0)$ and which has an associated cost $\hat{c}^{-}$, can always be found. The reason is that, as $\hat{p}$ is reduced, the term in curly brackets on the right hand side of this expression rises relative to the left hand side. Moreover, G rises as $\hat{p}$ is reduced and has a limit of $G = 1$ for small enough $\hat{p}$. Therefore, the equation also has a solution for a $\hat{p} < p_0$ even though the left hand side exceeds the right hand side for $\hat{p} = p_0$.

It then follows that the firm charges $p_1(c)$ for $c \leq \hat{c}^-$. For such low cost realizations, the firm's payoff is higher when it lowers its price even though it thereby reveals its cost. For cost realizations between $\hat{c}^-$ and $\tilde{c}$, on the other hand, the firm is better off charging p_0. Thus, the range of cost realizations for which prices remain constant is larger at this equilibrium. Moreover, this equilibrium also features a minimum size for price declines, namely $(p_0 - \hat{p}^-(p_0))$. Figure 5 also displays the minimum price declines implies by this specification. Somewhat surprisingly, these minimum price declines are larger than the minimum increases that correspond to the same base price. This occurs simply because, for this functional form, the loss in profits from a price that is too low relative to the monopoly level is larger than the loss in profits from charging a price that is too high by the same percent. Thus, the loss in firm welfare from not matching cost increases with price increases is larger than the corresponding loss from not matching cost declines with price declines.

The resulting asymmetry has a similar flavor than that uncovered empirically by Borenstein, Cameron and Gilbert (1997) who found a faster response of retail gasoline prices to crude oil price increases than to crude oil price declines.[11]

Because other versions of the model predict the opposite, namely that the minimum size of price declines is negligible, it is not apparent how data on the distribution of price declines relative to that of increases can serve to test the idea that the threat of customer anger affects price rigidity. A more robust implication of this idea seems to be that price changes tend to be smaller in magnitude when firms are already charging prices that can be viewed as fair or "low" while prices become considerably more rigid when the firm's costs are high relative to the expectations of consumers.

7 Conclusions

This paper has shown that a model of fairness in pricing can match several salient microeconomic observations about price adjustment. This includes the observation that prices are

[11] For more recent evidence of asymmetric price changes and several references, see Davis and Hamilton (2003).

variable across customers and across certain time intervals (namely when there are "specials") while they are relatively stable in response to other shocks. One attractive feature of the model is that, unlike Rotemberg (2002), I let consumers be quite sophisticated about what prices they ought to expect from firms that price fairly. One key advantage of this is that it tends to make consumers' concern with fairness less burdensome.

Suppose, for example, that the firm is in an inflationary environment and that, to prevent disappointments on the part of consumers who like to purchase at prices that are already familiar to them, the firm changes its prices infrequently. If the firm is not to be ruined by this practice, it must charge a price that is high relative to marginal cost whenever it changes its price, because inflation later erodes the firm's real price for some time until the firm adjusts its price again. Sophisticated consumers will come to understand that high prices relative to costs at the moment that prices are increased do not necessarily signal lack of benevolence and it is precisely this type of sophistication I have incorporated in my analysis. In particular, consumers have the correct theory of how costs ought to map into prices given the firm's circumstances. In a similar spirit, I have let consumers be correct about the level of altruism that they ought to expect from firms. This assumption may be responsible in part for my finding that the equilibrium allocation is shaped at least as much about this benevolence itself as about consumers' willingness to punish those firms whose behavior they deem insufficiently generous.

This sophistication on the part of consumers does come at a cost, however. In particular, it means that solving for equilibrium allocations is relatively complicated because the way consumers respond to off-the-equilibrium-path actions by firms must be related to the way firms react to changes in their actual environment. As a result, this paper is rather modest in the extent to which it tackles multi-period models. This is a weakness because the consequences of price rigidity depend a great deal on the timing of price changes, and this timing cannot be illuminated without a richer multi-period model. The formulation of a model of this sort that retains some of the consumer sophistication I have assumed here remains on the agenda for future research.

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Figure 1:

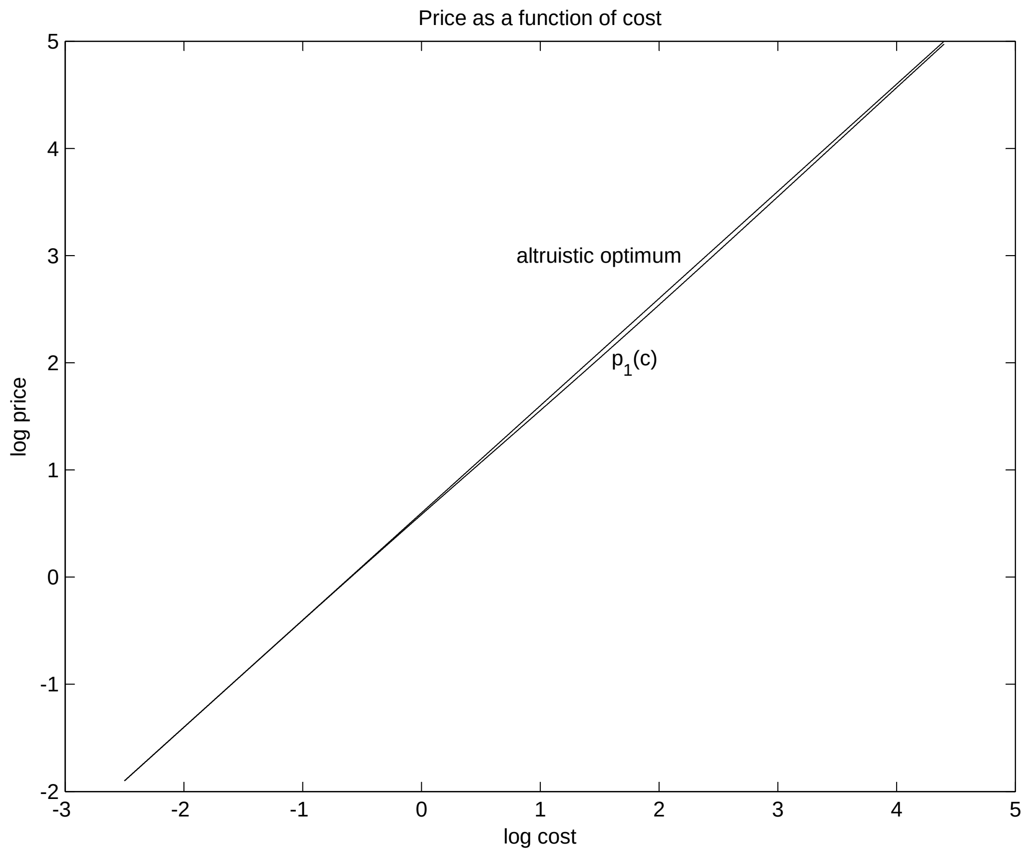
Price as a function of cost
altruistic optimum
p1(c)
log price
log cost
5
4
3
2
1
0
-1
-2
-3
-2
-1
0
1
2
3
4
5

Figure 2: Costs and Benefits of Shifting from One Market Clearing Price to Another

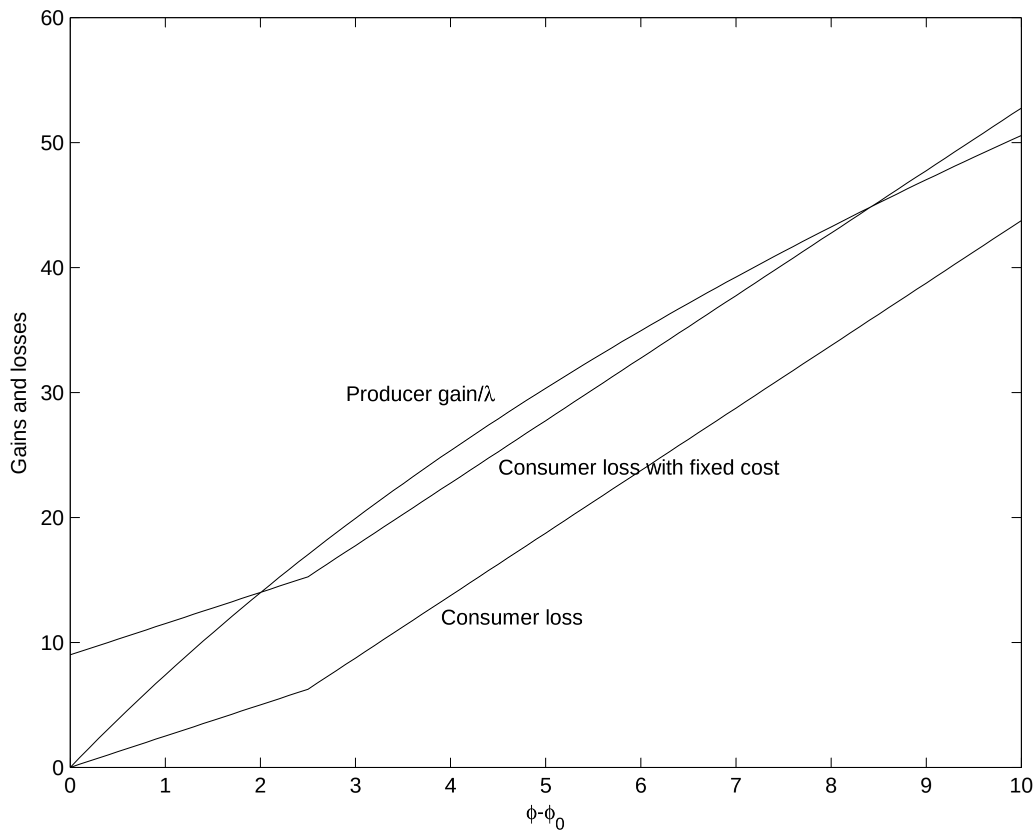

Figure 3: Costs and Benefits of Shifting from One Market Clearing Price to Another

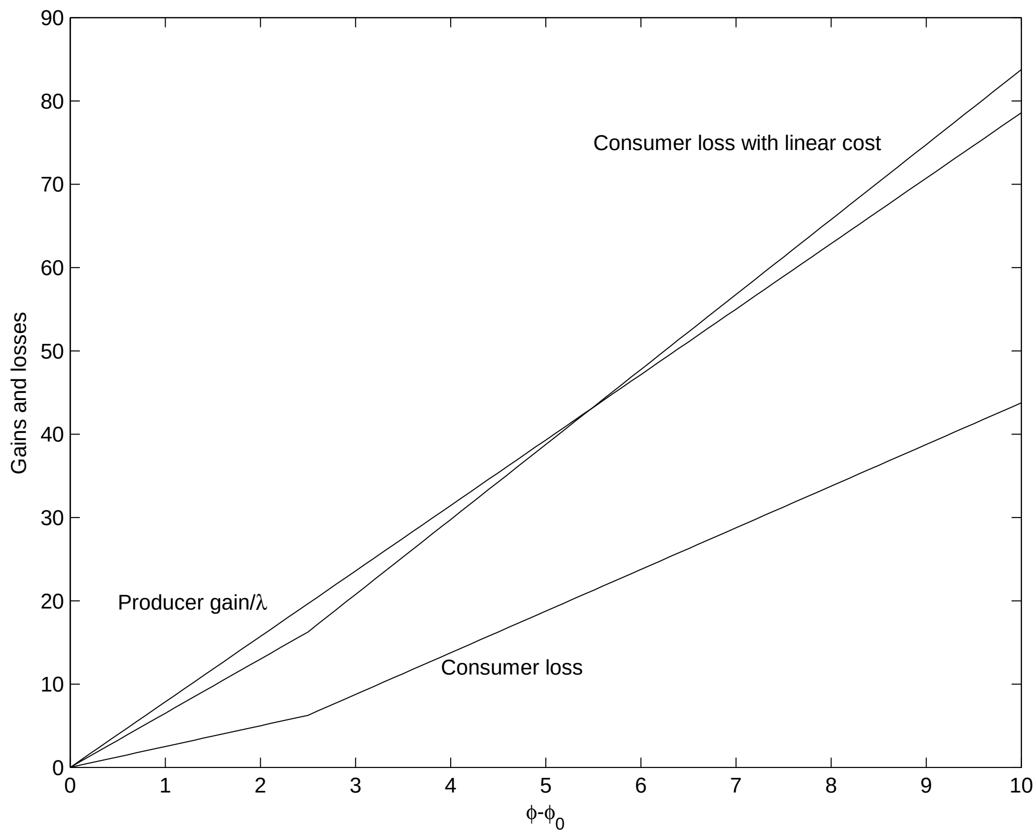

Figure 4:

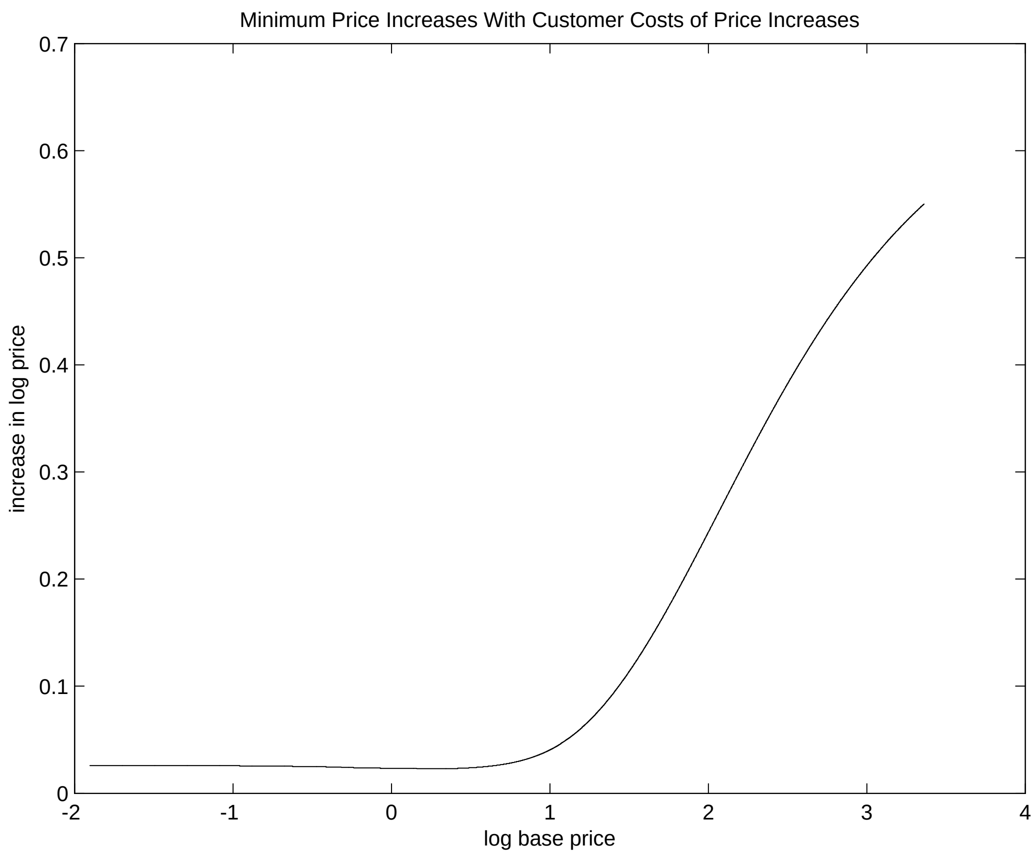
Minimum Price Increases With Customer Costs of Price Increases
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
increase in log price
-2
-1
0
1
2
3
4
log base price

Figure 5:


Minimum Price Changes with Consumer Inattention
1.4
1.2
1
0.8
0.6
0.4
0.2
0
change in log price
-2
-1
0
1
2
3
4
log base price
Price Decline
Price Increase