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ABSTRACT

I suppose that consumers see a firm as fair if they cannot reject the hypothesis that the firm is somewhat benevolent towards them. Consumers that can reject this hypothesis become angry, which is costly to the firm. I show that firms that wish to avoid this anger will keep their prices rigid under some circumstances when prices would vary under more standard assumptions. The desire to appear benevolent can also lead firms to practice both third-degree and intertemporal price discrimination. Thus, the observation of temporary sales is consistent with my model of fair prices. The model can also explain why prices seem to be more responsive to changes in factor costs than to changes in demand that have the same effect on marginal cost, why increases in inflation seem to affect mostly the frequency of price adjustment without having sizeable effects on the size of price increases and why firms often announce their intent to increase prices in advance of actually doing so.

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This paper proposes a model of what it means for prices to be fair and shows that its implications are consistent with several pricing practices as well as with many reactions of consumers both in laboratory settings and in actual markets. The central assumption of the model is that consumers require that firms demonstrate a minimum level of altruism towards them. This means that prices must be responsive to consumer preferences in ways that differ from the usual ones. If, in particular, consumers experience disappointment when they suddenly face increased prices, firms that act with the required level of benevolence must keep their prices somewhat rigid.

A search in Google gives 751000 hits for "fair price" while there are somewhat under 57000 for "equilibrium price". This fits with the ease that laboratory subjects have in answering questions about whether particular pricing patterns are fair. Such views have been elicited in the pioneering study by Kahneman, Knetsch and Thaler (1986), and have led to an extensive literature which is reviewed by Xia, Monroe and Cox (2004). An important finding of Kahneman, Knetsch and Thaler (1986) is that many respondents regard it as unfair for a firm to raises the price of an item whose demand has suddenly increased as a result of a change in the weather. By contrast, they generally regard it as fair if a firm increases its prices when the price of its inputs rise. Interestingly, these notions of fairness appear to be reflected in actual pricing practices. Firms often do increase their prices when costs rise. On the other dramatic increases in demand such as those caused by hurricane alerts are often accompanied by constant prices for emergency supplies, and stores often run out.

For example, stores in Baton Rouge, Louisiana ran out of generators, duct tape, flashlights and batteries on the eve of a hurricane in 2002.[1] A remarkable story of constant prices in response to a hurricane warning is reported in *The Washington Post* of September 19, 2003.[2] It reports that store manager Paul Ginetti, whose store had run out of flashlights priced at $4.97 each, managed to locate 1000 flashlights from an alternate manufacturer. At first he sold these for $4.97, but his supervisor made him raise their price to $11.98 when

[1] "Residents rushing to prepare for Isidore's visit", *The Baton Rouge Advocate,* September 25, 2002.

[2] The story ran under the heading "A Customer Flood for Home Depot; Va. Store Struggles To Meet Demand."

he learned that this was the list price for these flashlights. Some customers complained and, perhaps in part for this reason, Paul Ginetti later obtained permission from his supervisor to lower the price of these flashlights back to $4.97. Firms that act differently and do raise prices after a calamity raises demand, do so at their peril. The L.A. Times of January 30, 1994, for example, reported that irate consumers threatened stores that raised prices after an earthquake with boycotts.

Kahneman, Knetsch and Thaler's (1986) theory to explain their findings is that fairness considerations lead to a "dual entitlement." As they put it "Transactors have an entitlement to the terms of the reference transaction and firms are entitled to their reference profit." Reference transactions often refer to those that occurred in the recent past and, similarly, reference profits are those that the firm earned in the past.

This way of theorizing about fair prices appears to have three advantages. First, it fits well with the view that ethical behavior involves the heeding of absolute norms, since fairness in prices is defined by the requirement that firms respect certain rights. Second, it appears somewhat symmetric since both consumers and firms seem to be entitled to something they obtained in the past. In practice, however, Kahneman, Knetsch and Thaler (1986) do not treat these two rights symmetrically: consumers are only entitled to the terms of their reference transaction when this does not threaten firm profits, otherwise the rights of firms to change prices take precedence. Third, it seems to account for the unfairness of raising prices when demand rises due to a change in climactic conditions, since such a price increase would not only violate the norm against altering the terms of the consumers reference transaction but would also be unnecessary for protecting the sellers' profits (since these presumably rise together with sales even if prices stay constant.)

Unfortunately, the "dual entitlement" principle poses three types of difficulties. First, the consumers' entitlement to the "terms of the reference transaction" captures quite poorly what consumers consider fair when demand rises suddenly. Consumers do regard it as fair if posted prices stay constant in these cases, but they realize perfectly well that this often leads to rationing.[3] Rationed consumers do not receive the "terms of the reference transaction", indeed they do not even meaningfully face an unchanged price since the effective price at which they can obtain the item has suddenly become infinite.

The second problem with the principle is that there are many changes in circumstances where it is impossible to maintain firm profits, even if the firm were willing to violate the consumer's entitlement by changing prices. When there is a real increase in a factor's price, for example, even a firm that increases its price optimally will often experience a fall in real profits since its quantity sold will fall. Thus, in these circumstances, neither entitlement can be met, and the principle seems to lack any prediction for what price will be regarded as fair.

Lastly, the "dual entitlement principle" seems inconsistent with many fairness judgments in the laboratory. Dickson and Kalapurakal (1994), in particular, show that purchasers do not regard it as fair for prices to stay constant when costs fall, even though this is consistent with the principle. Along the same lines, maintaining a constant level of profits when factor costs rise requires that prices increase by more than marginal cost so that the firm makes up for its loss in volume. However, Bolton, Warlop and Alba (2003) show that firms that increase their price by more than the increase in their marginal cost are more likely to be seen as unfair. Thus the "dual entitlement" principle often fails to provide meaningful guidance about what prices would be fair and offers a prescription which seems incorrect in other cases.

The aim of this paper is to provide an alternative theory for fair prices. This theory seeks to explain not only the answers people give in the laboratory to questions regarding what prices they regard as fair but also tries to rationalize actual pricing practices. I focus not only on the responses to drastic changes in demand like those I just discussed, but also on four aspects of price rigidity that seem difficult to explain with models where this rigidity is due only to administrative costs of changing prices. The first of these aspects is that many

[3]What is more, 76% of Frey and Pommerehne's (1993) respondents regarded it as fair if 100 available bottles of water were distributed among 200 thirsty hikers on a first-come first-served basis, while 73% regarded it as unfair if a higher price was used to allocate the limited supply of water.

stores hold temporary sales where prices fall temporarily only to return to their pre-special price when the sale is over. The second is that, as emphasized by Bils and Chang (2000) prices seem to be more responsive to changes in factor cost than to changes in demand that have the same effect on marginal cost. The third is that increases in inflation seem to be accompanied mostly by an increase in the frequency of price adjustment, and only marginally by an increase in the size of the typical price increase. As I discuss below, this is not what the Sheshinski and Weiss (1977) model predicts for standard specifications of demand. Lastly, many firms announce their price increases in advance. By contrast, Benabou (1989) shows that models with only administrative costs of changing prices predict nearly the opposite. In models of this sort, firms would like to prevent customers from buying goods in advance of price increases and this leads firms to surprise their customers with unexpected price increases. Pre-announcing price increases facilitates this customer speculation instead.

The theory I propose hinges on two key assumptions. The first is that consumers expect firms to be somewhat altruistic towards them and that they react with anger if firms prove to be insufficiently altruistic.[4] The fear of angry reactions then leads firms to act as if they were altruists regardless of whether they feel true benevolence towards consumers. The second key assumption is that consumers experience a loss over and above their loss in real income when they learn something that makes them wish they had carried out a different set of transactions at an earlier time. As discussed by Bell (1983), this loss is best thought of as regret. In my context, consumers experience this regret when they must pay more for an object that they could easily have obtained at a lower price earlier. In this way, the "terms of the reference transaction" that play such a central role in Kahneman, Knetsch and Thaler (1986) play an important role here as well.

However, I suppose that consumers are also upset when they are no longer able to buy a good that was available earlier, since this ought to generate at least as much regret as having to pay a higher price for a good. By keeping its price constant, a firm prevents the regret of

[4]This idea also underlies Rotemberg (2002) whose focus, however, is on short term macroeconomic fluctuations and whose motivation for price rigidity is not based on regret.

customers that obtain the good at the old price at the cost of ensuring the regret of those who are rationed. As long as the latter are sufficiently less numerous than the former, it becomes possible for an altruistic firm to prefer to keep its price unchanged.

There is independent evidence for both the assumptions that consumers care about the benevolence of firms, and that they wish to avoid regret. According to Connolly and Zeelenberg (2002), regret is "the emotion that has received the most attention from decision theorists." Much of the empirical research on regret involves asking subjects about the extent to which they regret various actions and outcomes. For example, Cooke, Meyvis and Schwartz (2001) demonstrate that subjects taking the role of consumers express regret (and are unsatisfied) if they pay high prices for a product after the product was available at a lower price. This regret (and reduction in satisfaction) is larger if consumers are "forced" to make the purchase because they have "run out of the good". This displeasure could, by itself, be interpreted as being simply the result of a loss in real income. There is, however, evidence that people are willing to pay not to learn what would have happened had they followed alternate courses of action.[5] In the study of Cooke, Meyvis and Schwartz (2001), subjects have a different reservation price for a good depending on whether they do or do not subsequently learn the price at which it becomes available later. Since the actual income of the purchasers is independent of the price they would have paid had they not purchased (and since subjects are made unhappy by low future prices that indicate, if anything, higher future income) it seems that subjects suffer a direct loss in utility if they learn they could have done better through alternate courses of action.

There is also some evidence that consumers wish firms to be benevolent. First, firms spend nontrivial resources touting the loftiness of their their goals. Johnson & Johnson, for example, heavily advertises 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

[5] This is the essence of Bell's (1983) model of regret.

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."[6] 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.

Campbell (1999) provides more direct evidence that consumers approve of benevolent acts by firms. She 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. As in the studies discussed above, 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. It also fits more generally with firms' effort to trumpet their charitable activities.

A nearly immediate implication of firm benevolence is that firms with market power would like to charge less to customers whose marginal utility of income is higher. The reason is that such firms gain less total utility from extracting an additional dollar from someone who values it highly than they do from extracting an additional dollar from people who value it less. This desire to treat different customers differently could rationalize temporary sales if individuals with higher marginal utility of income are more likely to take advantage of these sales. Surprisingly, temporary sales arise out of firm altruism even if all customers have the same marginal utility of income and the same elasticity of demand. The reason, as I show, is that temporary sales can often be a particularly effective way to charge less on average than a selfish firm would.

This model obviously does not establish that temporary sales are a manifestation of firm altruism. However, it does establish that consumers who observe temporary sales should not necessarily be upset with firms for their lack of benevolence. This is important because the

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

paper shows that constant prices are often a good policy for firms that want to prove their altruism, and temporary sales obviously represent a departure from this. One big difference between this departure and other price variations is that those individuals who do not take advantage of the sale tend to be those that do not even become aware of its existence. This lack of awareness leads them not to be disappointed when they purchase at the same regular price that prevailed the previous time they observed the item's price.

Before proceeding, it is worth discussing briefly another alternative to using altruism as a model for fairness in pricing. Huppertz, Arenson and Evans (1978) define fair prices as involving an "equitable distribution of the benefits" from the exchange between consumers and firms. This is similar in spirit to the preferences considered in Fehr and Schmidt (1999) and Bolton and Ockenfels (2000) where individuals have preferences for relatively equal outcomes. One bit of evidence against this hypothesis is provided by Huppertz, Arenson and Evans (1978) themselves. They show that consumers who receive a better deal tend to see firms as treating more fairly, so that an orientation towards the welfare of customers seems to be associated with fairness. Second, if this theory were correct, the role of fairness considerations in pricing would have to be fairly limited because, in practice, the distribution of "benefits" between customers and firms - where these benefits are admittedly difficult to define and measure - seems to depend heavily on industry characteristics. Market power, in particular, plays a large role on the extent to which firms appropriate such benefits.

Along the same lines, firms that make considerable losses are not always seen as fair. Even firms in financial trouble are quite likely to be seen as unfair if, as emphasized by Campbell (1999), their acts are construed as having insufficiently positive intent. Letting customers focus on a firm's altruism has the advantage of ensuring that the intent of firms does indeed play a central role in customer attitudes. Lastly, as shown in Rotemberg (2004), a focus on altruism by no means precludes obtaining equilibria where outcomes are equal. Indeed, Rotemberg (2004) shows an altruism-based model quite similar to the one considered here induces equal splits in ultimatum games with more reasonable parameter values than those that are necessary to justify such splits if one uses the preferences in Fehr and Schmidt

(1999) or those in Bolton and Ockenfels (2000).

The paper proceeds as follows. The next section introduces my preferences for consumers and firms and shows that firms that want to appear altruistic will practice third degree price discrimination. They will, in particular, seek to give price breaks to individuals with a higher marginal utility of income. Section 2 studies how prices of such firms change when there are changes in demand and cost conditions that are known sufficiently far in advance that the firm can change its production volume. I consider changes in demand that are so sudden that it is difficult to increase quantity supplied in the following section, and this is where I introduce price rigidity due to consumer regret. Section 4 is devoted to temporary sales. Section 5 turns its attention to a setting where, in spite of the resulting customer regret, the firm changes its price regularly because there is constant inflation. This allows me to contrast the present model of price rigidity with that of Sheshinski and Weiss (1977), which involves only administrative cost of price changes. I focus particularly on the desirability of pre-announcing price increases and on the effects of changes in the rate of inflation on the frequency of price adjustment. Section 6 concludes.

1 Preferences

I suppose that individual preferences are quite similar to those in Rotemberg (2004) so that the psychological well-being of agent i is given by

$$W_i = x_i + [\lambda_i - \xi(\hat{\lambda}_j, \bar{\lambda}_i)]x_j \tag{1}$$

where x_i is agent i's "material payoff, *i.e.* the part of his utility that is independent of the outcomes for the other agent, λ^i is the agent's altruism parameter while the variable $\hat{\lambda}^j$ represents the beliefs of agent i about λ^j. The function ξ takes a value $\bar{\xi}$ which is greater than λ^i if agent i can reject the hypothesis that $\lambda^j \geq \bar{\lambda}^i$ and equals zero otherwise. This means that agent i is willing to incur costs to inflict harm on agent j if he can reject the hypothesis that the latter's altruism is at least equal to $\bar{\lambda}^i$. Otherwise, he feels some altruism and gains utility when the agent is better off as a result of agent i's actions.

My focus is on a firm, which sets a price, and on its consumers, who decide how much to buy from the firm. I am neglecting other actions by consumers, though angry consumers are often able to inflict damage on firms in other ways than by stopping their purchases. Consumers who are upset at firms also complain loudly, and it seems likely that this is unpleasant for firm owners (either directly or because it leads to unhappy employees that require some form of compensation). In addition, angry consumers can mobilize politicians against firms, and it seems likely that this is costly to firms even it does not lead to regulatory changes.[7] The threat of political movements against firms may well have a very different effect on individual firm behavior than the threat of the cessation of purchases I study here, because the effect of the former on any individual firm may well be quite unrelated to this particular firm's actions.[8] In part for this reason, I ignore these other reactions in this paper, and focus on consumer purchases only. As will become apparent below, a high ξ leads to a reduction - and even to a complete cessation - in purchases when consumers are angry . In some cases this is the empirically relevant outcome, particularly when the picketing of a store by angry consumers drives away other consumers.[9] 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. The extent to which the costs borne by firms in these cases resemble those that flow from the cessation of purchases will need to be studied in further research.

I suppose that consumer i's material payoff is $V(U_i(q_i)+I_i-p_iq_i)$, where p_i and q_i are the price paid and the quantity purchased by i respectively while I_i is his income. The functions U_i and V are increasing and concave. This formulation has the advantage of leading to simple demand curves while preserving the idea that different consumers differ in their marginal

[7] The State of Florida has a statute which imposes penalties on firms that charge "unconscionable" prices when the Governor declares a state of emergency following a natural disaster. Florida's law specifies that prices are unconscionable if they are "grossly" larger than those that were charged earlier and if this increase is not justifiable by a rise in costs. See http:www.800helpfla.com̃cspdfsstatute_price_gouging.pdf.

[8] Any individual landlord, for example, probably has only a very modest influence on the likelihood that rent control legislation will be passed.

[9] See "Quick Stop in Waunakee is picketed" *Wisconsin State Journal* September 13, 2001 for the story of a consumer who responded to a gas station that raised its prices after the September 11, 2001 attack by picketing the station and thereby led the station to close.

utility of income as a result of differences in the level of income. In this section, I suppose that there are two types so that i equals either 1 and 2, and I let N_i denote the number of consumers of each type. I suppose that these two types are observably different from each other and cannot resell the product so that the firm can charge them different prices. Thus, the firm's total sales Q equal $N_1q_1 + N_2q_2$.

Letting $C(Q)$ represent the cost of producing Q units, the firm's material payoffs x^f are a function of its profits π

$$x^f = v(\pi) \qquad\qquad \pi \equiv \sum_i N_i p_i q_i - C(Q)$$

where v is either linear or concave. I suppose consumers are identical with respect to their altruism λ^c, with respect to the minimal level of altruism $\bar{\lambda}$ that they require and with respect to their beliefs about the firm's altruism, which I denote by $\hat{\lambda}^f$.[10] Consumer of type i then maximizes

$$W_i^c = V(U_i(q_i) + I_i - p_iq_i) + \tilde{\lambda}v(\pi) \qquad \tilde{\lambda} \equiv [\lambda^c - \xi(\hat{\lambda}^f, \bar{\lambda})] \tag{2}$$

The consumer's first order condition for q_i is

$$V_i'(U_i' - p_i) = -[\lambda^c - \xi(\hat{\lambda}^f, \bar{\lambda})]v'(p_i - C') \tag{3}$$

where primes denote first derivatives. In the normal case where the price p_i is above marginal cost C', the firm has something to gain from an additional sale. An increase in the altruism of the consumer towards the firm then induces the consumer to reduce U' by increasing his purchases and thereby reducing the distortion that is due to the excess of price over marginal cost. By the same token, if ξ is large because the firm is deemed to be insufficiently altruistic, the consumer reduces his purchases. To simplify the analysis, I suppose that consumers actually stop buying altogether when they can reject the hypothesis that the firm's altruism equals at least $\bar{\lambda}$.

[10] This simplification allows me to avoid modelling the important issue of how consumers communicate their beliefs about the firm's altruism to one another.

I ignore anger from the firm towards its consumers so that I let the firms maximize[11]

$$W^f = v(\pi) + \lambda^f \sum_i N_i V(U_i(q_i) + I_i - p_i q_i) \tag{4}$$

where λ^f is the firm's altruism parameter. Supposing that consumers are not angry at the firm, and assuming an interior solution, the firm's optimal price for consumer i satisfies

$$v'\left(N_i q_i + N_i(p_i - C')\frac{dq_i}{dp_i}\right) = \lambda^F N_i V_i'\left(q_i - (U_i' - p_i)\frac{dq_i}{dp_i}\right) \tag{5}$$

where the left hand side is the derivative of profits with respect to price. Using ϵ_i to denote group i's demand elasticity, this can be rearranged to yield

$$p_i = \frac{\epsilon_i(1 - \lambda^f \lambda^c)}{\epsilon_i(1 - \lambda^f \lambda^c) + \lambda^f V_i'/v' - 1} C' \tag{6}$$

This reduces to the familiar formula $\frac{\epsilon_i C'}{\epsilon_i - 1}$ when the firm is selfish and $\lambda^f = 0$. An increase in λ^f lowers the numerator of (5). It also raises the denominator in the plausible if $V_i'/v' > \lambda^c$ Since we expect the marginal utility of individuals to be no less than that of firms (so that $V_i'/v' \geq 1$) and we expect λ^c to be considerably smaller than one, prices decline when firm altruism rises. This makes intuitive sense since it implies that a more altruistic firm charges lower prices because this increases the happiness of its customers. If $\lambda^f > 0$, prices also fall when V_i'/v' increases. An altruistic firm is more inclined to cut prices if its customers have a higher marginal utility of wealth relative to the firm's own marginal utility of profits because this implies that the firm obtains more indirect utility when the consumer's budget constraint is relaxed by the price reduction.

Because price is falling in λ^f, consumers can use the prices charged by the firm as an indicator of firm altruism. In particular, the requirement that a firm have a minimal level of altruism translates into the requirement that the firm's price not be larger than a threshold price. Consider in particular the prices $\bar{p}_i$ that satisfy (6) when λ^f is replaced by $\bar{\lambda}$. These are the largest prices that are consistent with $\bar{\lambda}$ since firms would only charge higher prices if

[11] In a one-period setting it would be hard to incorporate firm anger since firms set their price first and consumers purchase afterwards. There is thus nothing for the firm to react to. In a multi-period setting, angry reactions by the firms are easier to imagine, though I ignore them for simplicity.

they had lower levels of altruism. Thus, firms that charged higher prices would be punished by consumers.

The prices $\bar{p}_i$ exceed marginal cost C' as long as $\bar{\lambda}^f V_i'/v' < 1$. Firms thus cover their marginal cost at these prices if the required level of altruism is such that firms prefer a dollar in their pocket to a dollar in the pocket of their consumers. The observation that firms are not required to make cash transfers to their consumers suggests that, indeed, the required level of altruism is lower. What distinguishes a low price from a direct transfer is that the former costs the firm less. The reason for this is that a price reduction raises sales so that, when price exceeds marginal cost, price reductions reduce profits by less than they reduce the payments of consumers on the units that they were already purchasing.

If marginal cost decreases sufficiently little with the quantity produced, and particularly if it is nondecreasing, the firm covers all its cost at $\bar{p}_i$. There is then an equilibrium where all firms whose altruism is lower than or equal to $\bar{\lambda}$ charge these prices. Firms whose altruism parameter is lower than $\bar{\lambda}$ would prefer higher prices but are kept in check by customer's refusal to buy at prices above $\bar{p}_i$. Firms whose $\lambda^f > \bar{\lambda}$, by contrast, simply charge the price given by (6) using their own λ^f.

I now consider this equilibrium. If the two groups of consumers have the same ϵ_i, the group whose income I is lower so that its resulting V' is higher pays a lower price. The model thus rationalizes the existence of lower prices for groups that are generally seen as poorer, such as students and the elderly. This equilibrium also features higher prices for groups that have a lower elasticity of demand, just as in the conventional analysis with selfish firms. However, the requirement that the firm act altruistically mutes the effect of demand elasticity on price. To see this, note that $\bar{p}_1/\bar{p}_2$ equals

$$\frac{\bar{p}_1}{\bar{p}_2} = \frac{\epsilon_1}{\epsilon_2} \frac{\epsilon_2(1 - \bar{\lambda}\lambda^c) + \bar{\lambda}V_2'/v' - 1}{\epsilon_1(1 - \bar{\lambda}\lambda^c) + \bar{\lambda}V_1'/v' - 1}$$

The derivative of this expression with respect to $\bar{\lambda}$ is

$$\frac{\epsilon_1[V_2'(\epsilon_1 - 1) - V_1(\epsilon_2 - 1)]}{\epsilon_2[\epsilon_1(1 - \bar{\lambda}\lambda^c) + \bar{\lambda}V_1'/v' - 1]^2}$$

Suppose that price differences are due exclusively to differences in the elasticity of demand so that $V_1' = V_2'$, and that, without loss of generality, $\epsilon_1 < \epsilon_2$ so that the firm wishes to charge a higher price to group 1. Then this expression is negative, meaning that a higher $\bar{\lambda}$ shrinks the ratio of the two prices towards one. Some intuition for this result can be gained by noting that firms are required to charge a price equal to marginal cost if $\bar{\lambda}V'/v'$ is equal to one. It is thus not surprising that increases in $\bar{\lambda}$ make the two prices converge towards one another.

This result can to some extent rationalize the anger expressed by consumers when they concluded that Amazon.com was tailoring its prices to individuals by using its information about these individuals' past purchases.[12] If setting up a price discrimination mechanism of this type has a fixed cost, then this price discrimination will not be profitable for altruistic firms (who do not get to vary their prices by all that much) whereas it will be profitable for selfish ones. Thus evidence that a firm has set up such a system could be used to infer that it is insufficiently altruistic. Amazon, for its part, denied any intention to discriminate among customers who differ in their purchase pattern, and gave refunds to those who had paid more.

Complaints are much more muted against the airline industry's practice of charging different prices depending on the whether separate flight segments are bought at the same time and whether the segments are separated by a Saturday night, even though this also makes prices for individual items depend on other the items bought by the same customer. One possible reason for this difference in customer reaction is that many discounts do go to individuals who are arguably less rich. Insofar as leisure travellers are seen as having a higher V' than business travellers, charging less to leisure travellers is consistent with an equilibrium such as the one where firms charge $\bar{p}$.

A similar type of price discrimination is common in electronic goods, where products with better features are often sold at substantially higher prices even though their costs of

[12]See "On the Web, Price Tags Blur; What You Pay Could Depend on Who You Are," *Washington Post*, September 27, 2000.

production are not much greater. Indeed, as discussed by Deneckere and McAfee (1996), the cost of producing the less effective product is often either the same or slightly higher because the less effective product is an intentionally damaged version of the more effective one. It is worth studying whether, empirically, buyers of the more effective products tend to be richer, as would be required for my theory to explain these price differences. Insofar as more effective products require less time to perform similar functions, one would expect this to be the case, since people who earn higher wages ought to place a higher opportunity cost on their time.

While the equilibrium where firms charge $\bar{p}$ has many attractive features, it is generally not the only equilibrium of the model even if all consumers agree on $\bar{\lambda}$. To see this consider a strictly lower set of prices $\tilde{p}_i$ such that the firm continues to break even. Suppose that consumers believe that firms with an altruism parameter equal to $\bar{\lambda}$ charge these prices and only less altruistic firms charge higher ones. Firms, even those whose altruism is below $\bar{\lambda}$ will then charge $\tilde{p}_i$ because they know that they would lose all their sales if they charged more. There is then no reason for consumers not to suspect that any firm that does charge more is indeed more selfish, so that punishing firms that charge more is consistent with their utility function (2).

An unappealing feature of these equilibria with lower prices is that they depend on consumer reactions that seem unreasonable. Actions that an altruistic firm would take in the absence of fears of punishment ought to be sufficient as indicators of genuine altruism, particularly in a setting where it is straightforward for all players to know what an unconstrained altruist would do. A slightly different way of criticizing these equilibria is to note that they depend heavily on each firm's willingness to do exactly what it expects other firms to do so that it can escape being seen as selfish. In a model where there is incomplete information so that firms are unsure what will trigger punishment, one would expect such equilibria to be less plausible than equilibria where each firm's actions are at least somewhat responsive to its own circumstances. Because the resulting signaling considerations complicate the analysis, this paper focuses only on actions the firm would take if it had an altruism parameter equal to the minimum altruism demanded by consumers.

2 Changes in Factor Costs and in Planned Demand

I now consider how a firm that acts as if it had an altruism parameter of $\bar{\lambda}$ responds to the factors that affect marginal cost. For simplicity, I set $\lambda^c = 0$ from now on and use λ to denote the firm's altruism. In this section, I focus on changes that are known in advance of the time the firm sets price and hires the factors that are needed to produce Q. This means that the firm can set this quantity in such a way that demand at the price chosen by the firm is equal to Q. For simplicity, I suppose that there is only one type of consumer so that N consumers each buy the quantity q at the price p. I simplify the analysis further by supposing that the elasticity of demand ϵ of these customers is constant and by setting $\lambda^c = 0$, though consumers still insist that firms act as if their altruism parameter is at least equal to $\bar{\lambda}$.

As before, I imagine that marginal cost depends on Q. In addition, I let C depend on a parameter ψ that captures the effect of factor costs. Thus, using (6) and remembering that $U' = p$ because consumers are selfish when they are not upset at the firm, the price of a firm that acts as if its altruism parameter were λ is

$$p = \frac{\epsilon}{\epsilon + \lambda V'/v' - 1} C_1(N_1 q_1, \psi) \tag{7}$$

where C_1 represents the derivative of V with respect to its first argument and is thus equal to marginal cost.

The two shocks I consider in this section are a change in the number of customers N, which is a type of change in demand, and a change in ψ, which can be interpreted as a change in factor cost. Because I am focusing on a single firm, one can view the change in the number of customers as a change in the relative demand for different products, with a firm's gain in customers matching other firms' decline. Because I suppose that both C_2 and C_{12} are positive, changes in ψ are best thought of as changes in the firm's factor markets.

It is then straightforward to establish three results.

Proposition 1: i) If $v'' = 0$, the percentile response of prices to changes in ψ and N is independent of the altruism parameter λ.
ii) If $v'' < 0$ and $C_{11} > 0$, increases in N raise prices by strictly less if $\lambda > 0$ than if $\lambda = 0$.
iii) If $v'' < 0$ and $C_{11} > 0$, a given increase in marginal cost C_1 leads to a smaller increase in price if this increase is due to a change in N than if it is due to an increase in ψ.
Proof Changes in N and ψ generally induce changes in q, but do so only through the change in demand induced by the change in p. Thus, the percent change in q equals ϵ times the percent change in p. Using this, and the fact that v depends only on π, differentiation of (7) gives

$$\left(1 + \epsilon_1 \frac{QC_{11}}{C_1}\right)\frac{dp}{p} = \frac{QC_{11}}{C_1}\frac{dN}{N} + \frac{C_{12}}{C_1}d\psi + \frac{\lambda V'/v'}{\epsilon + \lambda V_1'/v' - 1}\frac{v''\pi}{v'}\frac{d\pi}{\pi} \tag{8}$$

If v'' were zero, so that v' is locally constant, the percent changes in price would obey the same equation as if the firm acted selfishly (though the level of the price would be different) and this establishes i) . If, by contrast, v were concave, the last term indicates that increases in profits would tend to lower the price when the firm acts altruistically. The reason is that, for a given λ, increases in profits make the marginal utility of customer income loom larger relative to the marginal utility of firm income.

Profits are given by $pQ - C(Q, \psi)$ so that

$$d\pi = Qdp + (p - C_1)\left[\frac{dq}{q} + \frac{dN}{N}\right] - C_2 d\psi$$

Since q varies only because of the change in p, one can use (5) to obtain

$$d\pi = (p_1 - C_1)qdN_1 - C_2 d\psi + \frac{\lambda V'Q}{v'}dp \tag{9}$$

If the firm acts selfishly, the last term is zero. Because an altruistic-acting firm lowers its price below the selfish optimum, it acts in a region where its profits increase with its price. Using (9) to substitute for $d\pi$ in (8), the change in price is given by

$$A_p \frac{dp}{p} = A_N dN + A_\psi d\psi \tag{10}$$

$$A_p = 1 + \epsilon \frac{QC_{11}}{C_1} - \frac{(\lambda V'/v')^2}{\epsilon - 1 + \lambda V'/v'}\frac{v''pQ}{v'} \qquad A_N = \frac{qC_{11}}{C_1} + \frac{\lambda V'/v'}{\epsilon - 1 + \lambda V'/v'}\frac{v''q(P - C_1)}{v'}$$

$$A_\psi = \frac{C_{12}}{C_1} - \frac{\lambda V'/v'}{\epsilon - 1 + \lambda V'/v'} \frac{v'' C_2}{v'}$$

These equations allow one to see some of the effects of varying the parameter λ. As long as $v'' < 0$, an increase in λ raises A_p and A_ψ while reducing A_N. A_ψ rises with λ because an increase in ψ directly lowers profits so that v' rises and the firm is more inclined to raise its price. The same logic explains why A_p rises with λ. Increases in price raise the profits of a firm that acts altruistically and thereby lower v' together with the desirability of raising prices. Similarly, A_N falls with λ because increases in N raise profits. The effects on A_p and A_N, together, imply that price unambiguously rises less with N when $\lambda > 0$ than when the firm acts selfishly and this establishes ii).

I now demonstrate iii). This result is trivial when $A_N < 0$ since, in this case, an increase in marginal cost due to an increase in N actually leads to a price reduction. To prove the result for $A_N > 0$ in a straightforward manner, it is actually easier to consider the reverse problem and imagine changes in N and ψ that lead to the same price change. This means that $A_N dN = A_\psi d\psi$ or that

$$\left[\frac{qC_{11}}{C_1} + \frac{\lambda V'/v'}{\epsilon - 1 + \lambda V'/v'} \frac{v'' q(P - C_1)}{v'}\right] dN = \left[\frac{C_{12}}{C_1} + \frac{\lambda V'/v'}{\epsilon - 1 + \lambda V'/v'} \frac{v'' C_2}{v'}\right] d\psi \qquad (11)$$

On the other hand, the change in C_1 induced by these two changes are

$$qC_{11} dN + \left\{NC11 \frac{dq}{dp} \frac{dp}{dN} dN\right\} \qquad \text{and} \qquad C_{12} d\psi + \left\{NC11 \frac{dq}{dp} \frac{dp}{d\psi} d\psi\right\}$$

respectively. Because I start with a case where the two price changes are the same, the terms in curly brackets are identical. Using (11), the difference between the increase in marginal cost due to dN and that due to $d\psi$ is thus

$$qC_{11} dN - C_{12} d\psi = -\frac{\lambda V'/v'}{\epsilon - 1 + \lambda V'/v'} \frac{v''}{v'} [q(P - C_1) dN + C_2 d\psi] \qquad (12)$$

In the case of a price increase, $C_2 d\psi$ must be positive, and the same must be true for dN if $A_N > 0$. The expression in (12) is then positive and increasing in λ, if and only if $\lambda > 0$. Firm altruism thus implies that a given price increase must be associated with a larger increase in marginal cost when it is a response to an increase in the number of customers than when it is a response to an increase in factor costs. The reason, once again, is that profits tend to rise more in the former case, and such profit increases ought to lead altruistic firms to moderate their prices. ■

The reason that factor prices have a larger effect on the prices is that firm profits fall when factor prices increase. This suggests that prices should be less affected by changes in opportunity costs that do not have an effect on actual costs. Indeed, a firm that has positive inventories of an input whose price goes up experiences, if anything, a rise in profits rather than a fall and it would thus be less acceptable if it increased its price. Vaidyanathan and Aggarwal (2003) provide questionnaire evidence that people do indeed perceive such price increases as less fair than price increases that are triggered by increases in costs that firms must actually pay.

The result that prices respond more to factor prices than to increases in demand that increase marginal cost by the same amount fits with evidence presented in Bils and Chang (2000) as well as with several earlier studies which they discuss. It is not clear that this result has, by itself, implications for the way that prices respond in general equilibrium to changes in aggregate demand as opposed to changes in factor costs. As stressed for example in Rotemberg and Woodford (1991), there are important conceptual differences between changes in a firm's individual demand and changes in aggregate demand (or in the demand for the typical firm).

In particular, it is difficult to extend the result concerning the number of customers to an aggregate setting. In such a setting an increase in the average number of customers also requires an increase in the number of people earning income, for otherwise the new customers would have no resources to spend, and this would also affect factor markets. More generally, the aggregate income that individuals have available for spending at any given moment is closely related to the income they earn from producing, so that it is difficult for people to spend more (as is required by an increase in aggregate demand) without there also being an increase in the total quantity of production. This, however, begs the question of how and why output increases in the first place.

One way that this could occur is if firms increased their demand for labor. Workers would then have more income to spend and demand for the typical firm would increase. In many models, increases in the demand for labor are motivated by increases in labor productivity. In my notation, this would entail changes in ψ, however. The demand for labor would also rise if firms reduced their markup of price relative to marginal cost, since this would lead firms to hire additional workers even though this would increase their marginal cost of production. One simple mechanism that induces this behavior is price rigidity in the face of increases in nominal marginal cost.

Like standard models without explicit costs of changing prices, the model in this section cannot rationalize this behavior. However, altruistic behavior by firms towards consumers expands the range of reasons for price rigidity. In particular, it implies that any costs that consumers pay when prices are changed must be taken into account by firms. I show this in the next section, where I focus on an extreme form of price rigidity that seems difficult to rationalize with purely administrative costs of changing prices.

3 The Fairness of Raising Prices when Demand Rises Suddenly

In this section I consider a continuum of consumers who differ in their valuation for a single unit of the good at a point in time. The good was previously available at price p_0 and I introduce a psychological cost to consumers when this price changes. In particular, I suppose that positive departures of the current price p from p_0 induces a regret cost of $\ell(p-p_0)$ where $\ell(0) = 0$ and $\ell(x) > 0$ if $x > 0$.

I suppose that the only well functioning market for purchasing the good is at a store that posts a price p. There is no resale market so that, if the store runs out, consumers who are turned away from the store cannot obtain it at any price. Such consumers incur the regret cost $\bar{\ell}$.[13] The absence of a resale market also means that there is no mechanism that ensures

[13] The complete absence of a resale market is obviously an extreme case. An empirically more appealing

that the limited quantities of the good that are sold at p go to the customers that value it most highly. Rather, I suppose that purchasers are randomly drawn from the population that is willing to pay p for the good.

I let the material payoffs of each potential consumer be given by

$$V((\phi + a - p)x + I) - w_0\ell(p - p_0) - w_1\bar{\ell} \tag{13}$$

In this equation, x equals 1 if the person buys the good and 0 otherwise, ϕ is a parameter shifting the demand for all individuals and a is distributed across individuals with pdf $F(a)$ and support $[a_L, a_H]$. The variable w_0 equals 1 if $a > p_0 - \phi$ so that the individual would have bought the good if its price continued to equal p_0, and equals 0 otherwise. Lastly, the variable w_1 equals 1 $x = 0$ even though $a > p - \phi$ so that the individual would buy the good if it were actually available at p. 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 its sales volume beyond Q in the short run. Since I am focusing on situations where demand has increased abruptly, I suppose that demand at price p_0, $N(1 - F(p_0 - \phi))$ is larger than Q. I show that, nonetheless, a firm that acts as if it had an altruism parameter of λ might decide to keep its price constant. One obvious alternative to keeping the price constant is to charge the market clearing price p^*, which satisfies

$$N(1 - F(p^* - \phi)) = Q.$$

Even if the firm chooses not to charge the market clearing price, one might expect it to prefer a slight price increase to a strictly constant price. Moreover, small price changes are

case would have a limited resale market. One might suppose, for example, that while a fraction g of potential customers is unable to get the good at price p, a fraction f of these can buy them from the fraction $1 - g$ non-rationed consumers. One might further speculate that the fraction f that obtains the good pays a market clearing price that exceeds the price that would clear the overall market. This would capture the idea that intermediaries exist that are able to funnel some items from people who bought them at p to people who are willing to pay considerably more. Popular toys, for example, often appear on Ebay at prices far in excess of suggested retail prices though producers try to foil these resellers by making only limited quantities available to any one customer. In other settings, such as snow shovels during snow storms, it seems more accurate to consider the limiting case where f is zero.

quite common so it may seem peculiar that they are not acceptable when demand increases a great deal. Nonetheless, Maxwell's (1995) respondents felt that responding to a blizzard by raising the price of snow shovels by a small amount was unfair - though less unfair than increasing these prices a great deal. The conditions under which the firm prefers p_0 to a slightly higher price are thus of interest, and I study them first. I show, in particular,

Proposition 2: Let

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

The firm prefers p_0 to a price slightly above p_0 if either the function ℓ is nondifferentiable at zero with $\lim_{x \to 0} > 0$ or if

$$Q_0 \ell'(0) > N\bar{\ell}F'(p - \phi) + \lambda N F'(p - \phi)(\tilde{U} - V(I)) + (v' - \lambda V')Q \tag{14}$$

where $\ell'(0)$ is the derivative of $\ell(x)$ at $x = 0$ and $Q_0 = N(1 - F(p_0 - \phi))$.

Proof Suppose that the firm charges $p < p^*$. Those individuals for whom $a < p - \phi$ do not wish to buy at p so that, leaving aside their regret, their material payoffs equal $V(I)$. The probability that someone with a higher a obtains the good is $Q(1 - F(p - \phi)/N$. If a person with such a valuation obtains the good, his material payoffs are given by (13) with $w_1 = 0$, otherwise, they equal $V(I) - \ell(p - p_0) - \bar{\ell}$. Taking expectations over realizations of a, an individual's expected material payoffs are thus

$$\bar{U} = V(I) + \frac{Q}{N}\tilde{U} - Q_0\ell(p - p_0)) - \left(F(p - \phi) + \frac{Q}{N} - 1\right)\bar{\ell}$$

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

$$\frac{d\bar{U}}{dp} = \bar{\ell}F'(p - \phi) + \frac{\tilde{U}F'(p - \phi) - \int_{p-\phi}^{a_H} V'(\phi + a - p + I)dF(a)}{(1 - F(p - \phi))N/Q} - \frac{Q}{N}\ell'(p - p_0) \tag{15}$$

This expression shows that consumers experience two benefits and two costs from an increase in price. The first term is the benefit from the reduction in the regret that is due to rationing. The density of people that stop being rationed, which is the same as that of the people who stop buying voluntarily, is given by $F'(p - \phi)$. The second term captures the benefit of allocating the good to individuals who value it more. A price increase ensures that some buyers who were just indifferent between buying and not buying the good, are replaced by buyers whose average valuation is $\tilde{U}$, which is positive. The density of such replacements is $F'(p-\phi)$ as well. The third term captures the income reduction due to the price increase while the last is the loss from the increase in regret at having to pay a higher price.

Since Q is fixed, the material payoffs to the firm from selling Q units at price p are pQ. Thus, an altruistic's firm's change in welfare when p changes is

$$Qv' + \lambda N \frac{d\bar{U}}{dp}.$$

Suppose for simplicity that all consumers have the same V', which could depend on ϕ since devastating weather changes presumably raise the marginal utility of income. This expression then reduces to

$$N\lambda\bar{\ell}F'(p-\phi) + \lambda Q \frac{F'(p-\phi)(\tilde{U} - V(I))}{1 - F(p-\phi)} - \lambda Q_0 \ell'(p - p_0) + (v' - \lambda V')Q$$

■

The first two terms on the RHS of (14) are clearly positive and capture the allocational benefits of raising p. One would normally expect the last term to be positive as well since firms should not typically be expected to have a level of altruism so large that they prefer a dollar in their customers' pocket to a dollar in their own. Thus, under normal circumstances, $(v' - \lambda V')$ is positive. However, these terms could be negative in the aftermath of a natural disaster, when consumers feel impoverished so that their V''s are high relative to v'. This is particularly the case for firms supplying goods that are needed in these circumstances, since one can expect these firm's sales volume to rise so that their v' falls.

Still, $\ell' > 0$, or a jump in ℓ at 0, make it considerably easier to justify holding prices constant rather than raising them slightly. This raises the question of whether having the function ℓ jump at zero, or even increase substantially, is reasonable. One reason why consumers may be averse even to small price changes is that price changes - no matter the size - require processing effort by consumers that can be avoided if prices remain unchanged. This can be rationalized by supposing that, for many consumers, the effort needed to remember the price paid in the past is larger than the effort needed to recognize this price when it is presented to them again. A consumer who fails to recognize the price that is presented to him must then go through a discrete additional effort to determine whether the price is reasonable. One bit of evidence that supports some elements of this logic is provided by Monroe and Lee (1999). They show that the fraction of consumers that correctly recalled a price that they saw before was significantly smaller than the fraction that could recognize the correct price from a list.[14]

Whether (14) is satisfied or depends not only on ℓ' and v'/V' but also on F'. If F' is low, the inequality can be satisfied even if ℓ' is modest. Moreover, it is easy to imagine that F' would indeed be low in the neighborhood of p_0 after a massive increase in demand. Right after a blizzard, demand is presumably not affected a great deal by a 10% increase in the price of snow shovels. Only after the price rises considerably more can one expect demand to fall to the point where only q is demanded. By contrast, a more modest increase in demand, seems more likely to lead to a more substantial F' at p_0.

So far I have only considered small price increases. Even in F' is modest near p_0 after a massive demand increase, it is presumably more substantial when price increases more. The problem is that, by the time the price has a substantial effect on demand, its increase may be so substantial that it generates a great deal of regret. A firm that acts altruistically would then refrain from large price increases as well. It would then be possible for prices to be more rigid when demand rises a great deal than when it rises more modestly. I now construct an example where, indeed, price is more likely to be constant after a big shock to demand than after a smaller one.

Suppose that 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

[14]Because lists have fewer elements than the possible number of prices that might be recalled, the number of errors would be somewhat smaller when consumers are presented a list that includes the correct price even if consumers pick their answer randomly. It is notable, however, that consumers also make fewer mistakes when asked to recognize a price from a list than they do when asked to remember the ranking of prices from different brands.

equals $N(\phi + a_H - p)/(a_H - a_L)$ for prices above this level. Thus, if $Q < N$, the market clearing price is $\phi + a_h - (a_h - a_L)Q/N$. If firms charge this market clearing price, consumer welfare is

$$V(I)(N-Q) - Q_0\ell(p-p_0) + N\int_{a_H-(a_H-a_L)Q/N}^{a_H} \frac{V(I + a - a_H + (a_H - a_L)Q/N)}{a_H - a_L}da \quad (16)$$

For prices below this level, either all N or $\frac{N(\phi+a_H-p)}{a_H-a_L} - Q$ consumers are rationed. This means that the probability that a consumer who wants to purchase the good at price p actually obtains it is

$$R \equiv \frac{Q(a_H - a_L)/N}{a_H - \max(a_L, p - \phi)}$$

Total consumer welfare is then

$$V(I)(N-Q) - Q_0\ell(p-p_0) - N\frac{\phi + a_H - \max(p, \phi + a_L)}{a_H - a_L}\bar{\ell} + NR\int_{\max(a_L, p-\phi)}^{a_H} \frac{V(\phi + a - p + I)}{a_H - a_L}da$$

Assuming that V' is constant and setting $V(I) = 0$ for simplicity, total consumer welfare when the price clears the market is

$$Q^2V'(a_h - a_L)/2N - Q_0\ell(p - p_0) \quad (17)$$

Otherwise their welfare is

$$QV'\left[\phi - p + \frac{a_H + a_L}{2}\right] - Q_0\ell(p-p_0) - (N-Q)\bar{\ell} \qquad \text{for} \qquad p < \phi + a_L \quad (18)$$

$$QV'\left[\frac{\phi - p + a_H}{2}\right] - Q\ell(p-p_0) - \left(\frac{N(\phi + a_H - p)}{a_H - a_L} - Q\right)\bar{\ell} \qquad \text{for} \qquad p \geq \phi + a_L \quad (19)$$

The first of these expressions declines in price more rapidly than the second. The reason is that, when all consumers are rationed because $p < (\phi + a_L)$, price increases do not (locally) improve the allocation of resources and therefore also fail to reduce the regret costs of rationing. For higher prices, increases in prices hurt consumers less. In the case where consumer income has not been massively disrupted so that we would expect $(v' - \lambda V') > 0$, we would also expect that

$$v' - \lambda\left(\frac{V'}{2} - \frac{Q_0}{Q}\ell'(p - p_0) + \frac{N\bar{\ell}}{Q(a_H - a_L)}\right) > 0$$

since $\bar{\ell}$ should be substantial relative to ℓ'. This means that a firm with altruism parameter equal to λ prefers local increases in prices once prices start having an effect on consumption. This condition ensures that, such an altruistic firm prefers the market clearing price to any price between $(\phi + a_L)$ and the market clearing price.

The question of whether it prefers either p_0 or the market clearing price to charging prices that are strictly between p_0 and $(\phi + a_L)$ is more complex. One sufficient, though by no means necessary, condition for this is

$$v' - \lambda(V' + \frac{Q_0}{Q}\ell'(p - p_0)) < 0 \qquad \text{for } p_0 < p < \phi + a_L \tag{20}$$

This condition implies that the firm prefers charging p_0 to any price between p_0 and $\phi + a_L$ on the grounds that price increases in this range cause too much disappointment for consumers.

If both of these conditions hold, the firm effectively faces the choice between charging p_0 and charging the market clearing price. To see which is better, suppose without loss of generality that p_0 is the market clearing price for the level of demand ϕ_0 and that $Q_0 = Q$. If, when the level of demand switches to ϕ, the firm charges the new market clearing price, its profits are $(\phi - \phi_0)Q$ larger than if it continues to charge p_0. Consumer welfare with the new market clearing price is given by (17) with $(p - p_0)$ replaced by $(\phi - \phi_0)$. If the firm sticks to p_0 and $\phi - \phi_0 > (a_H - a_L)(1 - Q/N)$, p_0 is below $\phi + a_L$ so that consumer welfare is given by (18) with p replaced by p_0. If, instead, $\phi - \phi_0 > (a_H - a_L)(1 - Q/N)$, consumer welfare with p_0 is given by (19) with p replaced by p_0.

This means that, for $\phi - \phi_0 > (a_H - a_L)(1 - Q/N)$ the loss to consumers from going to the new market clearing price is

$$Q\ell(\phi - \phi_0) + qV'\left[\phi - \phi_0 - (a_H - a_L)\frac{1 - Q/N}{2}\right] - (N - Q)\bar{\ell}$$

whereas this loss equals

$$Q\ell(\phi - \phi_0) + QV'(\phi - \phi_0)/2 - N\frac{\phi - \phi_0}{a_H - a_L}\bar{\ell}$$

when $\phi - \phi_0 < (a_H - a_L)(1 - Q/N)$.

To gain some insights into the determinants of whether a firm acting as if it had an altruism parameter of λ would switch over to the new market clearing price, Figures 1 and 2 show consumer losses and profit gains from such a change. Profit gains are deflated by λ because the firm is supposed to change its price when its profits from doing so exceed $\bar{\lambda}$ times the losses to consumers. The figures are drawn for V', v', a_H, a_L, N and Q equal to 2, 1, 10, 5, 10 and 8 respectively. Both figures include values of $\bar{\lambda}$ of both .35 and .45. Using a V' that is larger than one raises the weight put on consumer losses relative to producer gains for any given λ. The use of a high V'/v' seems particularly appropriate when a major disaster has struck that makes consumers feel impoverished. It is less attractive, however, in the case of demand changes that are not accompanied by changes in the marginal utility of wealth.

Figure 1 considers the case where $\bar{\ell} = 16$ while the disappointment losses from high prices are given by $\ell(x) = \min(16, 2x)$. The Figure shows that an altruistic firm would raise its price to the market clearing level if ϕ was not substantially larger than ϕ_0. Given that (20) is satisfied for this example, it would otherwise prefer to keep its price constant. It is important to see that this result hinges both on substantial altruism and substantial disappointment costs. Consumer disappointment costs without firm altruism lead the firm to always raise its price, since this increases profits. Similarly, with pure altruism and no disappointment costs, the firm would always change its price except in when consumers experience so much hardship that the firm is supposed to care more about a dollar in the consumer's pocket than a dollar in its own.[15]

One interesting conclusion of this Figure is that increases in altruism imply that the firm stops changing its price even for lower values of ϕ. This means that, while firms with either altruism parameter refrain from ever instituting large price increases (in response to large shifts in ϕ), more altruistic firms also refrain from smaller price increases. This

[15] One might think that even in this extreme case, the firm would prefer to charge the market clearing price and transfer resources to consumers in other ways. If, however, alternate methods for transferring resources also yield distortions, as they are likely to, transferring resources via a low price may be the firm's best method for accomplishing the transfer.

provides a possible rationalization for Maxwell's (1999) finding that respondents found large price increases more unfair (which I would interpret as being associated with lower altruism parameters) than smaller ones.

Because the disappointment costs of very small price increases are assumed to be trivial in the derivation of Figure 1, very small increases in ϕ do lead to price changes. An obvious alternative is to suppose that, in addition, there is a discrete increase in disappointment if the price is at all different from what it was in the past. This is considered in Figure 2, which is drawn under the assumption that $\bar{\ell} = 18$ while $\ell(x) = \min(18, 2(1 + x))$. The obvious effect of adding these fixed disappointment costs is that firms no longer make small price changes so that the price remains constant when ϕ differs only slightly from ϕ_0. The price changes that do occur, take place for intermediate levels of demand.

When demand suddenly increases, this model rationalizes consumer anger at price increases, and thus some rigidity in prices, both when consumer's marginal utility of income becomes very elevated and when consumers could have bought the good previously so that they are disappointed to have to pay a higher price. It should be noted, however, that consumers could also be disappointed if they had previously bought a complementary good to the one whose price suddenly increases. The model may thus be able to explain the fascinating case of gasoline rationing in California in 1920 that is discussed in Olmstead and Rhode (1985). In the period leading up to this rationing, tractor and automobile ownership expanded dramatically. There were 620,000 cars on the road at the end of 1918 and 906,000 at the end of 1920. The amount of gasoline sold did not keep pace with this increase in demand and the monopoly seller of gasoline, SOCal, held the line on prices while helping to institute a complicated rationing scheme. One interpretation of these actions that is consistent with my model is that many consumers might have been upset if their new vehicles suddenly became expensive to operate. One interesting aspect of this episode is that it is manifestly inconsistent with the idea that sellers whose customers have search costs keep prices constant because they are afraid that price increases will lead customers to search for alternative suppliers.[16] SOCal had no competitors to worry about and, indeed, prices appear to have been less rigid in more competitive gasoline markets.

A further implication of the theory is that there are circumstances where increases in demand ought not to translate more readily into price increases because there is less reason to expect anger at such increases. They both involve services, which are often harder to "store" than goods. Thus, purchasing a service before a price increase frequently fails to provide a similar utility flow as purchasing it afterwards. This means that the scope for regret after a price increase is reduced. One example of this is the provision of hotel services in cities that receive a large influx of visitors during a special event. In practice, hotels often raise their rates substantially for events such as the Cannes film festival or the Frankfurt book fair.[17]

A second example is the provision of repair services after changes in weather causes damages to physical property. Any impact of this damage on the marginal utility of income would have a similar effect on the acceptability of raising prices for these services as on the acceptability of raising prices for goods. The prices of the latter, however, should also be restrained by the empathy firms are supposed to feel for those who feel they could have bought the goods earlier. Thus, evidence on the way that different prices evolve after storms ought to help disentangle the importance of the regret channel that I have emphasized in my analysis.

4 Putting items "on special"

As discussed above, one reason to consider a model in which customers want their suppliers to be altruistic is that it can rationalize price rigidity in some circumstances. In other circumstances, it turns out, firm altruism can rationalize its opposite, namely price variations

[16]See Haddock and McChesney (1994) for an explanation of rigid prices along these lines. Stiglitz (1987), however, shows that this search-theoretic logic actually leads to multiple equilibria rather than to unique equilibria with rigid prices. The reason is that the belief by customers that other producers have changed their price then leads each producer to change its own, thereby rationalizing the consumers' beliefs.

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

in the absence of cost of changes. In this section I focus in particular on the ability of the model to explain why certain goods price alternate between being on special and being sold at "regular" prices. One fascinating aspect of this practice is that prices often return to exactly their pre-special value when the special ends. In other words, "regular" prices are quite rigid even though the price seems "flexible" in the sense that specials lead it to change relatively frequently.

The observation that the regular price returns to its previous value seems inconsistent with models such as Pesendorfer (2002) and the literature that precedes him, which base temporary sales only on variations in demand elasticity. The problem for these models is that the opportunity costs for inputs fluctuate constantly and these fluctuations in input costs ought to lead firms to charge different prices after specials end than before they begin.

The basic characteristics of specials also raise two questions for the type of model I consider here. The most general one is why price alternations between "regular" and "special" prices should be regarded as different from changes in regular prices. 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. One key difference between the two is that disappointment at facing a higher price than was available previously is likely to be much lower when a customer buys after the special is over. The reason is that customers who observe the higher price after the special is over fall into two categories: those that observed that the item was on special previously and those that did not. For those that did not, the return to the regular price is not seen as a price increase at all, so they have little reason to be disappointed. Now consider those that did observe the special price. If they were interested in buying the good, most of these presumably did so at the time since they knew that the special price would end. By doing so, they avoid paying the higher price and the attendant disappointment. Thus, the disappointed group, which consists of customers who saw that the item was on special and nonetheless deferred buying until the price rose again, ought to be relatively small.

It might be argued that even those customers who did not see the item on special are somewhat disappointed whenever they pay the regular price for an item that is known to be on special some of the time. The reason is that, while they do not know when they should have shopped for the item, they know that doing so at an earlier date might well have been advantageous. While I do not consider this cost explicitly, its existence implies that a firm that uses specials must be avoiding the ostracism of its customers through some other method of proving its altruism. In the setting I consider, what is altruistic about the firm is that it makes the good available, at least sometimes, at prices so low that the firm would become bankrupt if it charged these prices at all times. In effect, specials can be a particularly effective mechanism for lowering prices to customers, and we have already seen that altruistic firms tend to have lower prices.

The model I use has many of the elements in Pesendorfer (2002), who in turn builds on an extensive prior literature that he cites. Like much of this literature, I suppose that there are two types of customers, and that these differ in their valuation ω_i of the goods. Unlike Pesendorfer (2002), I let the number of individuals with valuation ω_i be constant over time and equal to N_i. This ensures that the elasticity of demand is constant over time. It thus 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).[18]

In period t, the firm charges a price p_t and sells quantity Q_t. Thus, variable profits in each period are $(p_t - c)Q_t$. Because specials last a short time, so that it should be easy for the firm to borrow and lend across periods, it does not seem appropriate to treat the firm as having a concave objective function over each period's profits. It is more appealing to suppose, instead that the firm's decision makers have a utility function that is concave in

[18]Pesendorfer (2002) presents evidence that the number of units sold at low prices is lower if prices in the previous week were low. This contradicts my model, if it is taken literally so that it requires that demand be independent of what has taken place in the past. However, what I seek to establish is only that temporary sales will be regarded as fair, and will thus be instituted by a firm that seeks to look altruistic, even if the elasticity of demand is constant. The right sort of variation in the elasticity of demand will further encourage specials, particularly if consumers are willing to see such variations as demonstrating altruism.

the average level of firm profits. This can be rationalized by supposing that managers are averse to having the firm dissolved and know that consistent losses lead creditors to demand such an action. By contrast, the extra benefit from having more than is necessary to meet these creditor obligations might be lower. I thus suppose that the firm's material payoffs are given by

$$v(E((p-c)Q)$$

where the expectations operator here takes averages over different points in time and v is increasing and concave once again. If v is sufficiently concave, and the level of altruism λ is sufficiently high, specials emerge in equilibrium. In particular

Proposition 3: Let Φ be the fraction of the time that the firm charges ω_1 and Δ be given by

$$\Delta = (\omega_2 - \omega_1)N_2 - (\omega_1 - c)N_1 \tag{21}$$

and consider the case where this is positive. If

$$\lambda > \frac{\Delta v'\Big((\omega_2 - c)N_2\Big)}{N_2(\omega_2 - \omega_1)} \tag{22}$$

the firm prefers $0 < \Phi < 1$ to setting Φ equal to either zero or one if U_f'' is sufficiently low.

Proof: By charging a price ω_1 a fraction Φ of the time, the altruistic firm's total payoff is

$$v\Big((\omega_2 - c)N_2 - \Phi\Delta\Big) + \Phi N_2 \lambda(\omega_2 - \omega_1)$$

If there were an interior solution for Φ, the first order necessary condition for this variable would be

$$-\Delta v'\Big((\omega_2 - c)N_2 - \Phi\Delta\Big) + \lambda N_2(\omega_2 - \omega_1) = 0 \tag{23}$$

Because v is concave, the derivative of the LHS with respect to Φ is negative. Inequality (22) ensures that the LHS of this equation is positive for $\Phi = 0$ so that the firm prefers a strictly higher level of Φ. If v' rises sufficiently as the firm's material payoffs decline,

$$-\Delta v'\Big((\omega_2 - c)N_2 - \Delta\Big) + \lambda N_2(\omega_2 - \omega_1) < 0$$

in spite of (22). This means that the firm prefers a Φ strictly smaller than one and that the optimum Φ is indeed interior and satisfies (23). ■

The advantage of charging the high price is that N_2 customers pay more while the disadvantage is that the firm foregoes the profit $\omega_1 - c$ on the N_1 low-valuation customers. My assumption that $\Delta > 0$ ensures that a selfish firm would always charge the high price ω_2. In each period that the firm charges ω_2, its customers obtain a surplus of zero. On the other hand, whenever it charges ω_1, the high valuation customers gain $\omega_2 - \omega_1$, which yields the firm $\lambda(\omega_2 - \omega_1)N_2$ in additional utility. When the firm's profits are high, and its marginal utility of income is low, these indirect benefits from its altruism loom large so that it wants to lower its price some of the time. If, instead, the firm is always charging low prices then its marginal utility of income is high, and it wants to reduce the fraction of the time that it sells also to the low valuation consumers.

Note that specials are much better for a partially altruistic firm than simply handing money to its customers. When a firm hands over money, its material losses are the same as the customers material gains. By putting a good on special, the firm loses Δ but, in the case where $\omega_1 > c$, this is less than the gain to the high valuation customers because the firm makes some profits from the low-valuation ones.

Before closing this section, it is worth noting that the concavity of v is necessary for the result given the other assumptions in the model. The reasons is that, because I consider a model with static demand curves, a linear v would imply a constant policy in equilibrium rather than one where prices alternate. Interestingly, the concavity of v does not induce alternating prices in the pure profit maximization case since the firms would then pursue the policy that maximizes profits each period rather than trading off profits in some periods for the welfare of the consumers with lower willingness to pay. Thus, this is a setting where altruism alone is responsible for temporary sales.

This raises the question of why altruism can lead to an optimum where the price varies over time even though one can always find a single price that maximizes $v + \lambda V$ at a single point in time. One important aspect of the example I presented is that the price that maximizes $v + \lambda V$ is quite different for high λ than it is for a selfish firm because the elasticity of demand becomes large at a price below the profit maximizing one. The result is that, for moderate λ, the firm prefers to alternate between the price that is optimal for high λ and the selfish optimum rather than choose a single price that is close to either.

5 Price Rigidity in the Face of Steady Inflation

Having shown that the avoidance of customer regret can explain both the return to the pre-special price and the absence of price changes when demand changes without a corresponding change in the quantity supplied, I now turn to a simple setting where the firm must cause this regret because it must change its prices. The reason it must do so is that its costs rise constantly so that it would ultimately make huge losses if it kept its price constant. I suppose in particular that is in an environment of constant inflation at the rate μ. The model I consider mimics closely that of Sheshinski and Weiss (1977) so that it is easy to see the similarities and differences between the administrative costs of changing prices that they explore and the consumer disappointment costs that I emphasize. I thus suppose that time is continuous and that, in addition to suffering a loss $\ell(p_t, p_{t-})$ at each date t where the price is changed from p_{t-} to p_t, each consumer has a utility function given by

$$\int_0^\infty e^{-rt}(U(q_t) + z_t)dt$$

where q_t represents their rate of consumption of the good in question and z_t represents the consumption of a numeraire good. I consider this numeraire only because it allows me to isolate what occurs in a single market; a more complete model would treat all goods symmetrically instead. The price of this numeraire good, p_{zt} grows at the rate μ, and consumers have access to an asset with an instantaneous rate of interest of i. Letting A denote the consumers' assets and $\dot{A}$ their time derivative, it follows that

$$\dot{A} = iA - p_t q_t - p_{zt} z_t + I_t$$

where I_t represents non-asset income. It follows that, unless $i = r + \mu$ individuals will not consume z smoothly over time. If this condition is satisfied, by contrast, individuals are indifferent as to when they consumes z. Each individual's utility is thus the same as if he reduced his consumption of z_t by one unit every time his consumption of q_t rose by p_{zt}/p_t units, since this response ensures that his budget constraint remains satisfied. This means that total utility is equal to

$$\int_0^\infty e^{-rt}\left(U(q_t) - \frac{p_t q_t}{p_{zt}} + I_t\right) dt \tag{24}$$

where I_t is independent of prices. Moreover, each individual's demand for q satisfies $u'(q_t) = p_t/p_{zt}$. With a mass N of consumers, total demand is given by $Q_t = d(p_t/p_{zt})$ with $d = Nu'^{-1}$.

As before, consumers also experience a disappointment loss at t of $\ell(p_t, p_{t-})$ if the price is changed at t from p_{t-} ro p_t. Crucially, I suppose that the function ℓ has a positive limit as p_t goes to p_{t-} from above, even though $\ell(x, x) = 0$. Just as Sheshinski and Weiss (1977) suppose that there is a fixed administrative costs of changing prices, I suppose that there is a fixed psychological cost of observing a price increase. In addition to the psychological reasons given above, this fixed psychological cost might exist because consumers are disappointed whenever they would have benefited from stockpiling the product just before the price increase took effect.

The instantaneous cost of producing the good is cp_{zt} so that this cost rises at the general rate of inflation μ. This means that instantaneous profits at t in terms of the numeraire good equal $d(p_t/p_{zt})[(p_t/p_{zt}) - c]$. A firm that acts as if it had an altruism parameter of λ thus maximizes

$$\int_0^\infty e^{-rt}\left\{d\left(\frac{p_t}{p_{zt}}\right)\left[(1-\lambda N)\frac{p_t}{p_{zt}} - c\right] + \lambda N U\left(d\left(\frac{p_t}{p_{zt}}\right)\right)\right\} dt + \lambda \sum_i e^{-r\hat{t}_i}\ell(p_{\hat{t}_i}, p_{\hat{t}_i -})$$

where $\hat{t}_i$ represent the dates where the firm changes its prices.

The discreteness of the costs of changing prices ensures that firms do not change their prices at every instant. To make the problem completely stationary, I suppose that ℓ depends on the percent change in the price, which is proportional to $(p_t - p_{t-})/p_{t-}$. The stationarity of the problem then implies that the firm keeps its price unchanged for intervals of length τ and that this interval length remains constant over time. Each time it picks a new price, it chooses the same real price $s = p_t/p_{zt}$ and it does so by changing its price by $100(e^{\mu\tau} - 1)$ percent. Let the function $W(y)$ be given by $d(y)((1 - \lambda N)y - c) + \lambda N U(d(y))$. Then the variables s and τ are chosen to maximize

$$\frac{1}{1 - e^{-r\tau}} \int_0^\tau e^{-rt} W(se^{-\mu t}) dt + \lambda e^{-r\tau} \ell(se^{-\mu\tau} - 1)$$

The first order condition of this maximization problem with respect to s is

$$\int_0^\tau W'(se^{-\mu t}) e^{-(r+\mu)t} dt = 0 \tag{25}$$

while that for τ is

$$\frac{e^{-r\tau}}{1 - e^{-r\tau}} \left\{ W(se^{-\mu\tau}) - \frac{r \int_0^\tau e^{-rt} W(se^{-\mu t}) dt + r\ell\lambda}{1 - e^{-r\tau}} - \lambda \ell' \mu s e^{-\mu\tau} \right\} = 0 \tag{26}$$

Integrating $\int_0^\tau e^{-rt} W(se^{-\mu t}) dt$ by parts and using (25), (26) implies

$$r\lambda\ell - \lambda\mu s e^{-\mu\tau}(1 - e^{-r\tau})\ell' = W(s) - W(se^{-\mu\tau}) \tag{27}$$

In the case where $\ell' = 0$, this equation is identical to the equation in Sheshinski and Weiss (1977) which states that the difference between firm welfare at the reset price and firm welfare at the terminal price equals the interest rate times the cost of price adjustment (which would be $\lambda\ell$ in the case where $\ell' = 0$). This equation is worth recalling because it plays a large role in the interpretation of my results concerning pre-announcements of price increases.

Before discussing this issue, however, I wish to focus on the implications of this model for the connection between the inflation rate μ and the time between price increases τ. To do so, it is helpful to concentrate on the special case where $U(q)$ is given by $\frac{\epsilon}{\epsilon-1} q^{\frac{\epsilon-1}{\epsilon}}$ so that the demand curve d has constant elasticity ϵ. The function $W(y)$ is then $\frac{\epsilon+\lambda-1}{\epsilon-1} y^{1-\epsilon} - cy^{-\epsilon}$ and the first order condition (25) implies that

$$s = \frac{\epsilon c}{\epsilon + \lambda - 1} \phi_0 \qquad \phi_0 \equiv \frac{e^{(\mu\epsilon - r)\tau} - 1}{e^{(\mu(\epsilon-1)-r)\tau} - 1} \frac{\mu(\epsilon - 1) - r}{\mu\epsilon - r} \tag{28}$$

This implies that, for any given τ and μ the price set by the firm is lower by the factor $\frac{\epsilon-1}{\lambda+\epsilon-1}$ when the firm has an altruism parameter of λ than when it is selfish. With these preferences, the first order condition (26) becomes

$$\frac{\epsilon+\lambda-1}{\epsilon-1}s^{1-\epsilon}\phi_1 - cs^{-\epsilon}\phi_2 = -\frac{\lambda\ell r}{1-e^{-r\tau}} + \lambda\ell'\mu s e^{-\mu\tau}$$

where

$$\begin{aligned}\phi_1 &\equiv e^{(\epsilon-1)\mu\tau} - r\frac{e^{((\epsilon-1)\mu-r)\tau}-1}{(1-e^{-r\tau})((\epsilon-1)\mu-r)}\\ \phi_2 &\equiv e^{\epsilon\mu\tau} - r\frac{e^{(\epsilon\mu-r)\tau}-1}{(1-e^{-r\tau})(\epsilon\mu-r)}\end{aligned}$$

Using (28), this implies that, in the case where ℓ is a constant so that $\ell'=0$,

$$c^{1-\epsilon}(1-e^{-r\tau})\left[\phi_2\phi_0^{-\epsilon} - \phi_1\phi_0^{1-\epsilon}\right] = \lambda\ell r\left(\frac{\epsilon+\lambda-1}{\epsilon-1}\right)^{\epsilon}$$

Differences in the altruism parameter λ obviously require different levels ℓ to justify a given τ, with lower levels of altruism necessitating larger disappointment costs if the firm is to keep its prices constant for the same amount of time. If, however, ℓ is adjusted to rationalize a particular τ for a given inflation rate μ, this equation implies that changes in inflation have the same effect on τ independently of λ. This can be seen by noting that the right hand side of this equation is independent of μ and τ, while the left hand side is independent of λ and ℓ.

Thus, when $\ell'=0$, altruism cannot help rationalize the connection between changes in the size of price increases and changes in inflation rates. This is worth emphasizing because the empirical connection between these magnitudes is not easy to rationalize with the Sheshinski and Weiss (1977) model. Cecchetti's (1986) data shows that the average price increase for his sample of magazines rose from 23.5 percent in the 1960's to 25.3 percent in the 1970's when the average yearly CPI inflation rose from 2.4 percent to 7.1 percent. Similarly, Lach and Tsiddon (1992) report that the average price increase for their sample of Israeli goods rose from 12.3 percent in the period 1978-1979:6 to 12.9 percent in 1982, while the overall monthly inflation rate rose from 3.9 percent to 7.3 percent from the first to the second period. Thus, in both cases, the average price increase rose only very marginally even as inflation rose substantially. This is not completely inconsistent with the idea that there are administrative costs of changing prices. If, for example, all consumers have exactly the same reservation price $\bar{p}$ for the product, then firms raise their price to $\bar{p}$ whenever they raise their price, and this implies that the percent price increase is the same regardless of the inflation rate.

For more standard demand curves, however, the size of the typical price increase ought to rise more with inflation. To see this, it is worth starting with the combination of λ and ℓ which ensures that prices rise by 12.3 percent when the inflation rate is 3.9 percent per month, as in the early sample of Lach and Tsiddon (1992). With $r = .0025$ (so that the real interest rate is about 3 percent per year), an increase in inflation to 7.3 percent implies that prices should rise by about 15.4 percent when they are changed for any constant elasticity of demand curve whose ϵ is greater than 1.5 and below 5. For more elastic demand curves, the price increase should rise somewhat more, but the effect of varying ϵ is modest. Similarly, if fixed costs are set so that prices rise by 23.5 percent with a 2.4 percent annual inflation rate, as in Cecchetti's (1986) observations for the 1960's, these parameters imply that an increase in annual inflation to 7.1 percent ought to raise the size of price increases to over 35 percent.

If the costs of changing prices were purely administrative, there is little reason to suppose that the real costs of changing prices would rise with the inflation itself. By contrast, it makes sense for disappointment costs to rise when the size of price increases rises. This means that $\ell' > 0$ and I consider the case where ℓ is given by the simple form

$$\ell = \ell_0 + \ell_1(e^{\mu\tau} - 1)$$

It is then possible to rationalize the findings of Cecchetti (1986) and Lach and Tsiddon (1992) with very small values of ℓ_1. Suppose in particular that $\lambda = .1$, $\epsilon = 2$ and $\ell_1 = 0.00035$. The value $\ell_0 = .0029$ the rationalizes a price change of 12.3 percent when inflation is 3.9 percent per month. A rise in monthly inflation to 7.3 percent, then implies that the size of price increases rises to 12.9 percent as in the data of Lach and Tsiddon (1992). Even though the size of price increases rises by nearly 5 percent, the disappointment costs rise by less than 1 percent.

Similarly, with $\lambda = .1$, $\epsilon = 2$ and $\ell_1 = .023$, a value of ℓ_0 equal to .26 is sufficient to rationalize the rather substantial 23.5 percent increase in magazine prices when the annual inflation rate is only 2.4 percent. With these parameters, an increase in annual inflation to 7.3% correctly predicts that the size of price increases rises only to 25.3%. While the size of price increases is now rising by 7.7%, the size of disappointment costs goes up only by 1.5% so that, by this metric, ℓ_1 is modest once again.

A positive value for ℓ_1 leads an altruistic firm to feel that reductions in the period over which prices are constant are advantageous to its customers because they reduce the size of disappointment costs. The usual benefit of lengthening this period is that the cost of price increases is postponed, and has value because the future is discounted at r. As the rate of inflation rises postponing a price increase by a given amount of time requires larger jumps in prices. With a positive ℓ_1, postponing price increases by one unit of time thus becomes less attractive when inflation rises, and this is the reason why ℓ_1 is so useful for rationalizing the empirical findings.

An alternative mechanism that might be able to rationalize the finding that the size of price jumps does not rise significantly when inflation rises is that firms are worried about speculation on the part of consumers. As in the analysis of Benabou (1989), this speculation becomes more severe when expected price increases are larger and this might limit the extent to which firms let price jumps increase as inflation rises. A more straightforward implication of Benabou's (1989) analysis is that firms that sell storable goods often should use mixed strategies if they have administrative costs of changing prices. By making the timing of their price changes random, such firms make it harder for consumers to profit from their speculation (since consumers who buy and store the good will then sometimes incur storage costs needlessly).

In an environment with other sources of uncertainty, even a deterministic relation between prices and costs may make it difficult for consumers to time their purchases to take advantage of impending price increases, so purposeful obfuscation may be less necessary to prevent this speculation. On the other hand, if the environment is random, the firm can also take positive steps if it wants to do the opposite, *i.e.* if it wants to facilitate consumer speculation. To do so, it can announce its price increases in advance. In a model where firms are selfish and where there are purely administrative costs of changing prices this would seem unwise since consumer that take advantage of temporarily low prices clearly lower firm profits.

Interestingly, many firms avail themselves of this opportunity and business newswires contain many price announcements of this sort. To gain some perspective on how common this is, I searched for "price increases," "announced" and "effective" in a publication that regularly carries such notices, namely *Business Wire*. Confining myself to the period 10/02 to 10/04 and ignoring the stories that matched my search criteria but were actually concerned with other issues, I found 44 stories pertaining to companies who made announcements of price increases. Of these, 14 (32%) announced price increases over one month in advance, 25 (57%) announced them less than one month in advance but over 10 days in advance and only 5 announced that these would affect shipments that would take place in the next ten days. Some of these pre-announcements specify that the new prices will apply to shipments beyond a certain date, so it is not entirely clear to what extent they allow consumers to speculate by buying goods before the planned price increase. Other stories are very specific on this point, however.

When Maxell, a large supplier of devices that store information on magnetic media, announced on December 2, 2003 that the price of its main products would rise by about 10% in February 2004, it explicitly said it was giving advanced warning so that Maxell customers would have "sufficient time to incorporate the pricing change into their future business planning." Similarly, the September 15, 2004 announcement by GrafTech that it was increasing electrode prices explicitly stated this price increase would only apply to orders received after October 1. More generally, announcements made with a large degree of advance notice such as Kimberly-Clark's announcement in March 2004 that it would increase its Kleenex prices by midsummer give customers the capacity to respond.[19]

[19]While the intertemporal substitutability of the purchase of prepared coffee might be subject to question, it is interesting that Starbucks gave about 10 days notice before raising its prices in September 2004.

I now consider a simple variant of the model I have developed in this section and show that, under plausible circumstances, firms that act altruistically would indeed avail themselves of the opportunity to preannounce price increases. The analysis proceeds in several steps. First, I set up a discrete time version of the model and continue to let the firm optimize over the timing of its price changes. I use this model to compute the size of the disappointment costs that are needed to rationalize a particular length of constant prices for a given inflation rate. Then, I suppose that (at least some) consumers are able to buy the good one period in advance if the firm preannounces its price increase. I then study numerically whether, for the disappointment costs I computed in the first step, the firm would prefer to avoid this consumer disappointment by letting consumers know its price change in advance. If the firm does so, I have found parameters for which the firm is unwilling to stick with an equilibrium where it does not pre-announce its price increases.

To begin with, I suppose that periods have discrete length and that production and consumption decisions get made once per period. I let i denote the one period interest rate and let ρ be the rate at which consumers discount the future. Thus consumer lifetime utility at t is

$$\sum_{j=0}^{\infty} \rho^j \left(\frac{\epsilon}{\epsilon - 1} q_{t+j}^{\frac{\epsilon-1}{\epsilon}} + z_{t+j} \right)$$

while consumer assets at t, A_t equal

$$A_t = (1+i)A_{t-1} - p_t(q_t + \hat{q}_{t+1}) - p_{zt}z_t$$

where $\hat{q}_t$ are purchases of goods at $t-1$ for use at t. I set these equal to zero for the moment, though I relax this assumption when I consider preannouncements below. For consumers not to strictly prefer a zero consumption of z_t in any period, it must be that

$$\rho(1+i) = (1+\mu) \tag{29}$$

where μ is the rate of growth of p_{zt}, and I assume this from now on. This condition ensures that consumers are indifferent as to when they consumer the good z. This utility function implies also that consumer demand for q_t, $d(p/p_z)$ is given by $(p/p_z)^{-\epsilon}$ and that total utility from having access to this good at price p/p_{zt} equals $(p/p_z)^{-\epsilon}/(\epsilon-1)$. An altruistic firm's welfare at t equals its profits in terms of good z at t plus λ times this consumer gain. Supposing that marginal cost is constant in terms of good z so that it equals cp_{zt}, an altruistic firm's instantaneous welfare is thus $W(p_t/p_{zt})$ where

$$W(p_t/p_{zt}) = \frac{\epsilon+\lambda-1}{\epsilon-1}(p_t/p_{zt})^{1-\epsilon} - c(p_t/p_{zt})^{-\epsilon}$$

If the firm keeps its price fixed for J periods and chooses the same real price $s = p_t/p_{zt}$ each time it changes its price, its total welfare is

$$\frac{\sum_{j=0}^{J-1}\rho^j W(s/(1+\mu)^j)}{1-\rho^J} - \frac{\lambda\ell}{1-\rho^J} \tag{30}$$

The firm then sets s to maximize the first term, which gives

$$s = \frac{\epsilon}{\epsilon+\lambda-1}\frac{\sum_{j=0}^{J-1}\rho^j(1+\mu)^{\epsilon j}}{\sum_{j=0}^{J-1}\rho^j(1+\mu)^{(\epsilon-1)j}}$$

To simplify the analysis I focus on the case where ℓ is independent of the size of the price change and thus of J. For a given $\lambda\ell$ and for the value of s given above, the expression in (30) reaches a maximum for at most two values of J. The reason is that this expression is rising in J for low values of J (because the second term rises rapidly when J is low) and falling in J when J is high (because the first term declines rapidly while the second term rises more slowly). As $\lambda\ell$ rises, the second term becomes more important, so the optimal J tends to rise. However, there is a range for $\beta\ell$, which I denote by $[r_J^-, r_j^+]$ such that the firm gains nothing by using a duration different from J. For $\beta\ell$ at the boundaries of this interval, the firm is indifferent between this J and either the J that stands immediately below it (in the case of r_J^-) or the one that stands immediately above it (in the case of r_J^+).

Since prices increase by a factor $(1+\mu)^J$ when they increase, we can easily deduce J from observing the size of price increases. If we know the parameters of the model, we can then also compute the range in which $\beta\ell$ must fall. The question is then whether, for this range of $\beta\ell$'s the firm is better off preannouncing the price increase. This presumably depends on the precise effects of this preannouncement. Here, I consider a simple setting and show numerically that such a preannouncement can indeed increase an altruistic firm's welfare even though it lowers profits.

The particular example I have in mind is one where customers who are told of the period t price increase at $t-1$ can purchase both q_{t-1} and q_t at $t-1$. Consumers buy each of these units at a real price in terms of z_{t-1} of $s/(1+\mu)^{J-1}$, which given (29) is equivalent to a real price in terms of z_t of $s/(\rho(1+\mu)^{J-1})$. Thus, the quantity $\hat{q}_t$ of these pre-purchases equals $(s/(\rho(1+\mu)^{J-1}))^{-\epsilon}$ and the time t utility from having access to these pre-purchases is

$$\frac{1}{\epsilon-1}\left(\frac{s}{\rho(1+\mu)^{J-1}}\right)^{-\epsilon}$$

Note that, if the firm raises its price to s at t, consumers who have pre-purchased make no further purchases as long as $\rho(1+\mu)^{J-1}$ is larger than one. If $\rho(1+\mu)^{J-1} < 1$ instead, the discount rate is sufficiently high that the consumer makes no pre-purchases. I thus consider the case where inflation is large enough that $\rho(1+\mu)^{J-1} > 1$.

From the firm's point of view, each unit sold of $\hat{q}_t$ delivers real revenues in terms of z_t of $s/(\rho(1+\mu)^{J-1})$ and has real costs in terms of z_t of c/ρ. Thus, an altruistic firm's instantaneous welfare from its sales of $\hat{q}_t$ in terms of z_t equal

$$\hat{W} = \frac{\epsilon+\lambda-1}{\epsilon-1}\left(\frac{s}{\rho(1+\mu)^{J-1}}\right)^{1-\epsilon} - \frac{c}{\rho}\left(\frac{s}{\rho(1+\mu)^{J-1}}\right)^{-\epsilon}$$

If, the firm did not preannounce its price increase, its instantaneous welfare from its sales at t would be

$$W = \frac{\epsilon+\lambda-1}{\epsilon-1}s^{1-\epsilon} - cs^{-\epsilon}$$

If the firm did pre-announce, it would not necessarily set the same price s for t as if it did not. However, to demonstrate that the firm prefers preannouncing, it is sufficient to show that it would have this preference even if it had to set the same price, and even if it could never preannounce again in the future. The gain from this one time preannouncement would then equal

$$\hat{W} - W + \lambda\ell$$

Take first the 1960's period studied by Cecchetti (1986). Supposing magazines keep their prices constant for 107 periods of one month each, which I infer from the fact that they raise their prices by 23.5% and the yearly inflation is 2.4%, $\beta\ell$ must equal between .239 and .246 if $\epsilon = 2$, $\lambda = .1$ and $\rho = .9975$. The difference between W and $\hat{W}$ is only .0032 for these parameters, so that preannouncements are clearly beneficial to such an altruistic firm. This might, of course, induce even selfish firm to make these announcements so that they keep their customers. Some intuition for this result, and its possible generality, can be gained by noting that $\hat{W}$ is nearly equal to the firm's instantaneous welfare in the last period in which it charges any given price. Thus, $W - \hat{W}$ is close to the increase in instantaneous welfare that accrues in the period that the firm raises its price. In continuous time, (27) ensures that this difference equals the interest rate times the cost of changing prices $\lambda\ell$. With discrete time, this is not exactly right, but should be close if periods are short relative to the length of time that prices remain fixed. Preannouncements, on the other hand, are worthwhile if this difference in one-period gain equals the level of $\lambda\ell$, which is of course much larger than the real interest rate times $\lambda\ell$. Thus, if periods are short relative to the length of time that price remains constant, preannouncements are attractive. The firm only loses the sales for a brief period and avoids a great deal of consumer disappointment.

With the same ϵ, ρ and λ, and continuing to use monthly periods, but using the inflation rates and implied duration of constant prices of Cecchetti's (1986) magazines for the 1970's, pre-announcement remains worthwhile for the entire range of possible $\lambda\ell$'s. This is also true in the case of the inflation and implied duration of constant prices in the early period studied by Lach and Tsiddon (1992). In their latter period, however, inflation runs at 7.3% per month and prices of the typical product change by 12.9% so that prices remain constant for less than 2 months. Using periods of one month, preannouncements cease to be attractive for the lower values of $\lambda\ell$ that are consistent with keeping prices constant for 2 months - though they remain attractive for the higher values of $\lambda\ell$ that lead to this degree of price rigidity.

6 Conclusions

If one is to have a "behavioral" theory of consumption, it seems important to sort out what makes customers see a price as "fair," since lack of fairness in prices elicits strong reactions by consumers. A perhaps equally important reason for seeking to model what consumers regard as fair is that the effort to appear fair may explain a number of observations about prices. Here I focused in particular on observation having to do with price rigidity and price variability. I have, in particular, tried to rationalize simultaneously the existence of "specials" where prices fall temporarily from their "regular" level, with the remarkable rigidity of regular prices. I have argued at the same time that fairness considerations might explain why prices seem more responsive to "costs" than to changes in marginal cost induced by changes in demand. Lastly, I have used the same fairness-based logic to explain why prices do not change in the face of certain natural disasters that increase demand, and to explain some aspects of price rigidity that do not seem to fit well with a model where the only costs of changing prices are administrative ones.

Because this is an initial effort at understanding the effects of a particular model of fair prices, I have considered models without explicit uncertainty and with symmetric information on the part of firms and consumers. Both of these assumptions need to be relaxed for the model to be more realistic. First, it is obvious that consumers have only imperfect information about firms' costs. Second, as I discussed above, firms sometimes generate substantial animosity with their prices. Given that negative consumer reactions often lead firms to make changes, it would seem that firms are also imperfectly informed about consumer's trigger points. What remains as an open question is whether a model with uncertainty of this type can explain one of the puzzling features of pricing found by Carlton (1986) and Kashyap (1995). They found that firms sometimes institute large price increases while they institute small ones at other times. Models with administrative costs of price adjustment do not tend to predict this heterogeneity. If, on the other hand, price rigidity is due to fears of reactions by consumers, it would seem reasonable to suppose that the information available to firms about these reactions affects the size of their price increases.

7 References

Bell, David E., "Risk Premiums for Decision Regret, *Management Science,* 29, October 1983, 1156-66.

Benabou, Roland, "Optimal Price Dynamics and Speculation with a Storable Good," *Econometrica,* 57, January 1989, 41-80.

Bils, Mark and Yongsung Chang, "Understanding the Response of Prices to Cost and Demand Factors," *Carnegie-Rochester Series on Public Policy,* 52, June 2000, 33-77.

Bolton, Lisa E., Luk Warlop and Jospeh W. Alba, "Consumer Perception of Price (Un)Fairness," *Journal of Consumer Research,* 29, March 2003, 474-91.

Campbell, Margaret C., "Perceptions of Price Unfairness: Antecedents and Consequences," *Journal of Marketing Research,*, 36, May 1999, 187-99.

Carlton, Dennis W., "The Rigidity of Prices," *American Economic Review,* 76, September 1986, pp. 637-658.

Cecchetti, Stephen G., "The Frequency of price Adjustment, A Study of Newsstand Prices of Magazines," *Journal of Econometrics,* 31, 1986, 255-74.

Connolly, Terry and Marcel Zeelenberg, "Regret in decision making," *Current Directions in Psychological Science,* 11, December 2002, 212-6.

Cooke, Alan D. J., Tom Meyvis and Alan Schwartz, "Avoiding future regret in purchase-timing decisions," *Journal of Consumer Research,* 27 March 2001, 447-59.

Deneckere, Raymond J. and R. Preston McAfee, "Damaged Goods," *Journal of Economics & Management Strategy,* 5, Summer 1996, 149-74.

Dickson, Peter R. and Rosemary Kalapurakal, "The use and perceived fairness of price-setting rules in the bulk electricity market," *Journal of Economic Psychology*, 15, 1994, 427-448.

Fehr, Ernst and Klaus M. Schmidt, "A Theory of Fairness, Competition and Cooperation," *Quarterly Journal of Economics,* 1999, 817-68.

Frey, Bruno S. and Werner W. Pommerehne, "On the fairness of pricing - An empirical survey among the general population," *Journal of Economic Behavior and Organization,* 20, 1993, 295-307.

Haddock, David D. and Fred S. McChesney, "Why do Firms Contrive Shortages? The Economics of Intentional Mispricing," *Economic Inquiry,* 32, October 1994, 562-81.

Huppertz, John W., Sidney J. Arenson and Richard H. Evans, "An application of equity theory to buyer-seller exchange situations," *Journal of Marketing Research,* 15, May 1978; 15, 250-60.

Kahneman, Daniel, Jack Knetsch and Richard Thaler, "Fairness as a Constraint on Profit: Seeking Entitlements in the Market," *American Economic Review,* 76, September 1986, 728-41.

Kashyap, Anil K.,"Sticky Prices: New Evidence from Retail Catalogues," *Quarterly Journal of Economics,* 1995, 245-74.

Lach, Saul and Daniel Tsiddon, "The Behavior of Prices and Inflation: An Empirical Analysis of Disaggregated Price Data," *Journal of Political Economy,* 100, April 1992, 349-89.

Maxwell, Sarah, "What makes a price increase seem 'fair'?" *Pricing Strategy & Practice,* 3, 1995, 21-27.

Monroe, Kent B. and Angela Y. Lee, "Remembering versus Knowing: Issues in Buyers' Processing of Price Information," *Academy of Marketing Science Journal,* 27, Spring 1999, 207-25.

Pesendorfer, Martin, "Retail Sales: A Study of Pricing Behavior in Supermarkets," *Journal of Business,* 75, 2002, 33-66.

Rotemberg, Julio J., "Customer Anger at Price Increases, Changes in the Frequency of Price Adjustment and Monetary Policy" *NBER Working Paper 9320,* November 2002.

— "Minimally Acceptable Altruism and the Ultimatum Game." *Harvard Business School Working Paper Series, No. 05-008,* 2004.

— and Michael Woodford, "Markups and the Business Cycle," *NBER Macroeconomics Annual 1991,* 63-129.

Sheshinski, Eytan and Yoram Weiss, "Inflation and Costs of Price Adjustment," *Review of Economic Studies,* 44, 1977, 287-303.

Stiglitz, Joseph E., "Competition and the Number of Firms in a Market: Are Duopolies More Competitive than Atomistic Markets?," *Journal of Political Economy,* 95, October 1987, 1041-61.

Xia, Lan, Kent B. Monroe and Jennifer L. Cox, "The Price is Unfair! A Conceptual Framework of Price Fairness Perceptions," *Journal of Marketing,*, 68, October 2004.

Vaidyanathan, Rajiv and Praveen Aggarwal,"Who Is the Fairest of Them All? An Attributional Approach to Price Fairness Perceptions," *Journal of Business Research,* 56, 2003 453-63.

Figure 1: Costs and Benefits of Shifting from One Market Clearing Price to Another

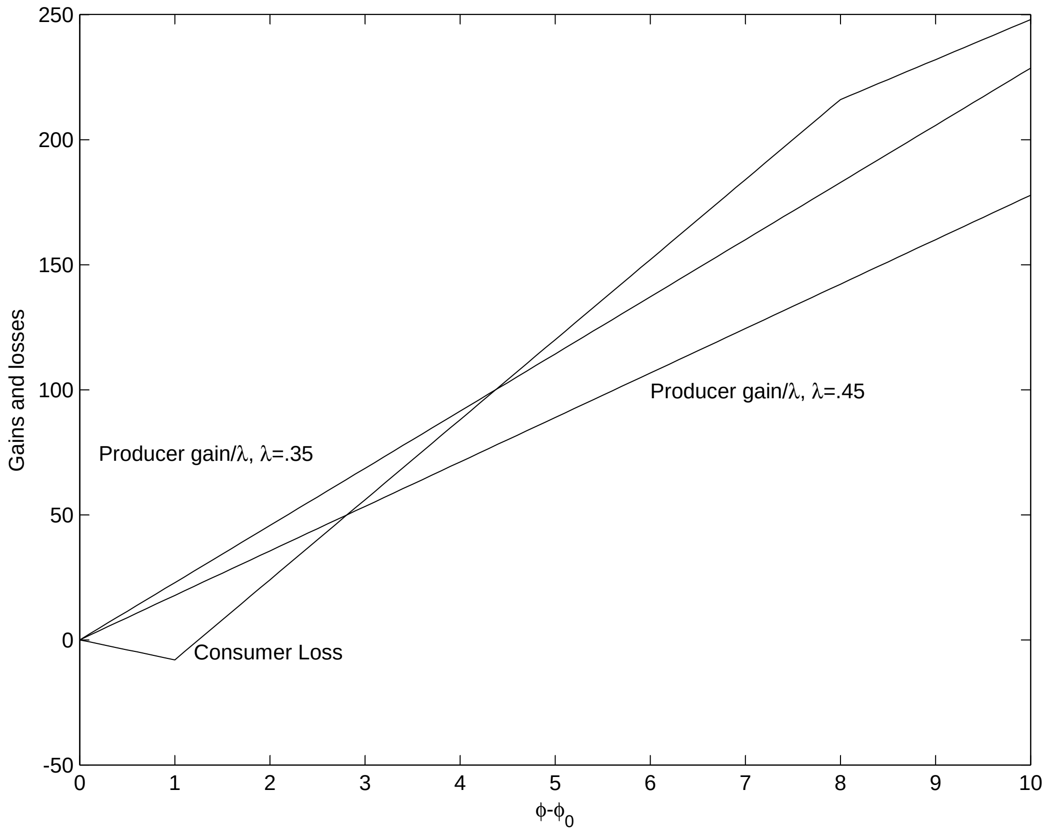

Figure 2: Costs and Benefits of Shifting from One Market Clearing Price to Another: The Case where Even Small Price Changes Cause a Discrete Increase in Disappointment