Customer anger at price increases, changes in the frequency of price adjustment and monetary policy

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Abstract

While firms claim to be concerned with consumer reactions to price increases, these often do not cause large reductions in purchases. The model developed here fits this by letting consumers react negatively only when they become convinced that prices are unfair. This can explain price rigidity, though its implications are not identical to those of existing models of costly price adjustment. In particular, the frequency of price adjustment can depend on economy-wide variables observed by consumers. This has implications for the effects of monetary policy and can explain why inflation does not fall immediately after a monetary tightening.

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1. Introduction

Price setters have been asked on repeated occasions to explain why their prices stay constant in nominal terms for periods of time that are vastly longer than the period over which the opportunity cost of production stays constant. The two most common answers received by Hall and Hitch (1939) involved the psychology of customers. They were, in particular, that “conventional price [is] in [the] minds of buyers” and that “Price changes [are] disliked by buyers.” Blinder et al. (1998) asked price setters about the validity of various theories of sticky prices developed by economists, so they did not ask directly whether price changes were disliked by customers. Nonetheless, a majority of their respondents volunteered that changing prices would “antagonize” or “cause difficulties” with their customers (p. 308).

The simplest model of such negative reactions would posit that the quantity demanded falls dramatically every time a price is increased, perhaps because price increases trigger search as suggested by Stiglitz (1984). However, many price increases are associated with only trivial instantaneous reductions in the quantity demanded. A second, and more standard explanation for the existence of periods where prices are fixed, involves the assumption that there are non-convex costs of changing prices. These costs are usually motivated by the observation that posting prices involves physical resources so that resources must be spent to change prices by, for example, printing new catalogues (Sheshinski and Weiss, 1977). While Levy et al. (1997) show that the resource costs of changing prices in supermarkets are nontrivial, these administrative costs simply cannot be the whole story.

To see this, Fig. 1 shows the prices charged by a supermarket chain for a particular product. A striking feature of this series is the recurrence of downwards spikes, short periods where this particular item is “on special”. In addition to new price labels, this often involves changes in the item’s physical display. The price changes again when the promotion is over though the supermarket often chooses exactly the same price as prevailed before the special. Thus, firms appear to have a preference for prices they have charged before even when the resource costs needed to post such prices are the same as those that would be needed to display any other price.

Another common approach to modelling price rigidity is to suppose that price setters have imperfect information (see Lucas, 1972). However, the prices of many raw materials are well publicized and move minute by minute while, at the same time, finished goods prices accounting for a large fraction of sales are set by a small number of individuals. It seems hard to believe that these individuals, who are presumably selected for their ability, fail to update their beliefs regarding optimal prices for months at a time. On the other hand, it seems quite plausible for customers to have poor information about the costs of producers, and this plays a key role in the model.

One attraction of focusing on how consumers perceive prices is that firms routinely say they want their prices to be “fair.” As discussed by Hall and Hitch (1939), many firms set prices using the “cost-plus” method which involves starting with variable unit cost, adding the average overhead cost per unit under that assumption that firms produce at “capacity” and, lastly, adding a margin of profit.
Oxenfeldt (1951, p. 158) reports: “Questionnaire and field surveys indicate the particular acceptance of a margin as ‘fair’ to be the most important reason for the widespread use of that margin.”

As emphasized in the questionnaire study of Kahneman et al. (1986), consumers also have opinions about the fairness of price changes. My theory of price rigidity hinges on the assumption that consumers use nominal price changes as a trigger for reflection about the whether producers are fair or not. Because price increases lead consumers to re-think the extent to which firms are acting fairly, firm will be reluctant to change their prices often. This fits with the suggestion that firms ought to try to “improve” their product when they raise prices. Miller (1976, p. 23) makes this suggestion to restaurants as a way to overcome customer resistance when printing a menu with higher prices. He recommends adding something (like potato chips) “to a standard item and creat[ing] a new package that includes the standard but can be sold for a slightly higher price”.

Consumers’ evaluation of the fairness of a price-changing firm depends on their information. As their information changes, their resistance to price increases should change as well. A firm that knows its customers would obviously time its price increases so they occur when resistance is relatively low. Thus, the random receipt of information by consumers can rationalize the random price changes assumed by Calvo (1983).

A difference with the Calvo (1983) model, however, is that price increases ought to be more frequent when the macroeconomic environment suggests that
such increases are fair. Thus, for example, high inflation in the past might con-
vince consumers that costs are likely to have increased and thus may make price
increases easier to sustain. This means that lagged inflation can have an effect on
current inflation even if price-setters are purely forward-looking. Considerations
of this type may help resolve some of the empirical difficulties faced by the
unmodified Calvo (1983) model. One well known property of this model is that it
tends to predict that realistic monetary contractions have their largest impact on
the inflation rate in the quarter in which interest rates are unexpectedly increased.
Empirically, by contrast, unexpected increases in interest rates seem to reduce
inflation only with a lag. While several modifications of the Calvo (1983) model
help resolve this inconsistency (see Rotemberg and Woodford (1997) and
Christiano et al. (2005)) it is worth understanding how customer anger can do so
as well.

Consider an environment with positive steady state inflation so that the typical
firm that changes its price raises this price. A contractionary monetary policy
typically reduces the size of this price increase because the reduction in demand tends
to lower marginal cost. In the case where price rigidity is caused by the fear of
consumer anger this can, paradoxically, increase the fraction of firms that raise their
price. The reason is that the price increase that firms now desire has just become
more palatable. This increased frequency of price increases can offset the decline in
the price chosen by those firms that change their prices. There is also a second reason
for an increase in the frequency of price adjustment in the immediate aftermath of a
monetary contraction, though I do not model this explicitly. This is that such a
shock makes firms realize that price increases will become less palatable once
inflation slows down. This acts as an incentive to raise price before inflation falls, and
thereby postpones the onset of low inflation.

The paper proceeds as follows. The next section presents some evidence on the
effects of price increases. It considers whether consumer “resistance” to price
increases boils down to a precipitous fall in demand at the moment that prices are
increased. Insofar as sales do not fall sharply every time prices are raised, the model
proposed in the subsequent section is more attractive. The reason is that this model
involves the possibility of sharp drops in sales if consumers feel the price increase is
unfair but, most of the time, firms will choose price changes that pass muster with
their customers.

Section 3 presents the model of consumer reactions to price increases. Section 4
turns to macroeconomic considerations by discussing a general equilibrium model
with random price changes where the frequency of price changes can depend on
observable economic variables. Section 5 then analyzes how this model behaves in
response to monetary policy shocks and Section 6 concludes.

2. What happens when prices are increased

Close observation of what happens to firms that change prices is likely to contain
important information about the causes of price rigidity. For this reason, I start by
studying some features of the scanner data from Dominick’s Fine Foods. These data contain weekly transactions data on price, sales and acquisition cost for a multitude of supermarket items. The data cover several of Dominick’s stores and pertains to the period that goes from September 1989 to May 1997. The prices for many of these items alternate between “regular” prices and “specials”. A typical example of this pattern is provided in Fig. 1, which plots the retail prices as well as the acquisition costs (averaged over stores) for the 16 oz. package of Nabisco Premium Saltines over the 380 weeks for which data are available. Over this period, the “regular” price of this item was changed 5 times. Within each period during which any particular regular price prevailed, there were several subperiods where the item was “on special” and was sold at a lower price. The Figure also shows that the acquisition cost varies closely with the retail price, from which it follows that the manufacturer is closely involved in most (if not necessarily all) decisions to change the retail price of this product.

Dominick’s also sells Nabisco Saltines with either no or low salt, as well as packages of different sizes. The 16 oz. package of Nabisco Premium Saltines is the most popular of these, but the other items with the same weight sell almost always for exactly the same price. Thus, this item seems representative of the Nabisco offerings of this product class. Several other manufacturers produce saltines, though only three additional brands were sold by Dominick’s for most of the duration of this particular sample. One of these is the Dominick’s brand, a second one is sold under the brand of Salerno. In addition, Dominick’s carried both regular and low salt saltines sold under the Keebler brand. Since the two Keebler products were almost always sold for the same price, the analysis focuses on Keebler’s regular product, which was more popular. The sales of Keebler and Dominick’s own brand of saltines were comparable, though considerably smaller than those of Nabisco’s brand. The sales under the Salerno brand were somewhat smaller that those of either the Keebler or Dominick’s brand.

The price that is “sticky” in this figure is the “regular” price and it is thus of particular interest to study the effects of changes in this price. Interestingly, the four brands carried by Dominick’s did not synchronize the timing of their “regular” prices changes. Nabisco’s Premium Saltines were first sold for $1.79, $1.89, $1.99, $2.19 and $2.29 in weeks 21, 108, 142, 327 and 364 respectively. Only the first of these price changes was accompanied by changes in the regular prices of any of the main competitors. Nabisco acted as a price leader in that competitors tended to follow its price increases, but with some delay. Salerno, for example, followed the third, fourth and fifth increases with price increases in weeks 149, 339 and 373,

1The data were obtained from http://gsbwww.uchicago.edu/research/mkt/Databases/DFF/Files.html. For a longer description, see Barsky et al. (2002).
2While my emphasis is on changes in regular prices, it is worth mentioning that total sales of this item are significantly larger during the weeks that the item is on “special.” Hendel and Nevo (2004) discuss similar evidence for other supermarket items and relate it to models where goods are storable.
3In giving the weeks in which various events took place, I use the nomenclature for “weeks” in the Dominick’s data base. This does not coincide perfectly with the way weeks are displayed in Fig. 1 because data is not available for certain weeks.
respectively. Keebler followed the second and fourth Nabisco increases with changes in weeks 116 and 338, while Dominick’s had a price change in week 333 and thereby followed Nabisco’s fourth increase. The first Nabisco price increase was unusual because Keebler also raised its price to $1.78 in week 21.

Before proceeding to the discussion of the changes in quantity that accompanied these price increases, it is worth noting that the first three of these regular price increases were preceded by having Nabisco’s Premium Saltines on special. The previous regular price had been charged in contiguous weeks ending in week 16, 104 and 137, respectively. To get a sense of what happened to Nabisco’s sales after regular price increases, I compare the average number of boxes sold in the first three weeks of the new price to the average sold in the last contiguous stretch where the previous regular price was charged to customers. This comparison might overstate the declines in sales brought on by the regular price increase if the intervening weeks where the product was on special led customers to stock up. In any event, the last two increases are free from this problem.

The results of this comparison are presented in Table 1, which also gives the weeks of “old” and “new” prices that are being compared, as well as the relevant percent change in regular prices. The table shows that, on two occasions, sales actually rise substantially after the regular price is increased while only once does the quantity decline significantly. While generalizing from this small set of numbers is precarious, it seems fair to say that regular price increases are not necessarily followed by big reductions in the quantity demanded, even if competitors do not match the price increases.

One potential interpretation of these observations is that Nabisco has information about the weeks in which demand for its own brand of saltines is higher and raises its price in those weeks. This cannot be ruled out although week-to-week demand changes in this industry seems difficult to forecast since weekly sales are quite

<table>
<thead>
<tr>
<th>Weeks of “old” price</th>
<th>Weeks of “new” price</th>
<th>% change in price</th>
<th>% change in boxes sold</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 13–16</td>
<td>21–23</td>
<td>16.3</td>
<td>–.12</td>
</tr>
<tr>
<td>2 89–104</td>
<td>108–110</td>
<td>5.6</td>
<td>23.4</td>
</tr>
<tr>
<td>3 132–137</td>
<td>142–144</td>
<td>5.3</td>
<td>–18.3</td>
</tr>
<tr>
<td>4 320–325</td>
<td>327–329</td>
<td>10.0</td>
<td>–4.6</td>
</tr>
<tr>
<td>5 356–362</td>
<td>364–366</td>
<td>4.6</td>
<td>23</td>
</tr>
</tbody>
</table>

This suggests that the fixed costs of physically posting new prices may play some role in the joint timing of promotions and regular price changes.

The advantage of using averages is that they are less affected by the considerable changes in week to week sales. So as to avoid excessive smoothing of what could be a sharp sales reaction, the analysis uses only the first three weeks with the “new” price to capture the effect of price changes. The results are not very sensitive to using only the first full week with the new price or just the last three contiguous weeks with the “old” price.
volatile. And, unless one supposes that Nabisco has very good information about these demand variations, the evidence of Table 1 seems inconsistent with theories where demand is kinked at the “old” price.\footnote{It is difficult to believe that this information is particularly good since sales fluctuations are extremely large even in periods with constant prices. For example, while all four major brands kept their price constant from week 33 to week 34, Nabisco’s sales fell by 21\% from the former to the latter.} Since competitive products whose price has remained constant are available nearby, the evidence suggests that individuals do not respond to price increases by immediately embarking on a search for a better deal. The evidence also seems inconsistent with a setting where customers feel that any price increase is sufficiently unfair as to lead customers to reduce their purchases. Rather it suggests that, insofar as customers react badly to price increases, they do so either with a delay or only occasionally.

Given that some price increases elicit strenuous objections right away, it seems more straightforward to suppose that consumers only react with anger on certain occasions. Moreover, the strenuous reactions that do occur appear to catch price setters by surprise. Consider, for example, the reaction to those stores that raised their prices in the aftermath of the earthquake that hit the Los Angeles area in January 1994. Some of these stores were visited by activists and threatened with boycotts (L.A. Times, January 30, 1994). The consumer reaction was so vociferous that Southland Corp. terminated its franchise agreement with several 7-Eleven franchisees who raised prices during the episode (The Orange County Register, 23 January 1994). The hypothesis that franchisees expected this particular reaction does not seem particularly plausible.

Loud complaints have also been voiced against European stores for “rounding up” prices when they converted them to euro’s. The extent to which this behavior actually raised average inflation is in dispute. Nonetheless consumer groups successfully called for a mass boycott of Greek stores in early September 2002 to protest the price gouging associated with the euro’s introduction (Reuters, September 2, 2002).\footnote{Using a voting procedure, \textit{Tyran and Engelmann} (2005) also induced boycotts in response to price increases in experimental markets.}

These violent reactions in dramatic historical episodes still leave open the question of whether the typical firm that changes its price faces a significant probability of consumer revolt. The evidence of Table 1 makes it clear that such revolts are not commonplace and suggests that firms change prices only when their subjective probability of a negative consumer reaction is low. As the model developed below indicates, firms may achieve this either by having good information about the likely reaction of consumers or by pricing conservatively.

\section{3. A one-period model with fairness concerns}

Consider a firm that must choose its price for one period and which, leaving aside fairness considerations, faces a production and preference structure similar to
Rotemberg and Woodford (1997). In particular, suppose a unit mass of households each produces his own differentiated good and that household $i$’s instantaneous utility at $t$ is given by

$$w_i^t = u(C_i^t) - v(\phi_i^ty_i^t) \quad \text{where} \quad C_i^t = \left[ \int_0^1 c_i^t(z)^{(\theta-1)/\theta} \, dz \right]^{\theta/(\theta-1)}, $$

(1)

where $u$ is concave and increasing while $v$ is convex and increasing, $\phi_i^t$ is a random variable indicating costs, $y_i^t$ is the output of household $i$ at $t$ and $c_i^t(z)$ is the household’s consumption of good $z$ at $t$.

Suppose that household $i$’s total expenditure on consumer goods equal $E_i^t$. Maximization of the utility function in (1) then implies that $C_i^t = E_i^t/P_t$ while his purchases of good $j$, $c_i^t(j)$, equal $E_i^t(P_i^j/P_t)^{-\theta}$ where $P_i^j$ is the price charged by household $j$ for its product and the price index $P_t$ is

$$P_t = \left[ \int_0^1 \left( P_i^j \right)^{1-\theta} \, di \right]^{1/(1-\theta)}. $$

(2)

This implies that, if all households maximize (1) and producers sell the quantity demanded by households, $y_i^t$ equals $(E_i^t/P_t)(P_i^j/P_t)^{1-\theta}$ where $E_t$ denotes total household expenditure at $t$. Suppose that producers only expect to make these sales if their prices are regarded as fair. In particular, there is a price $\bar{P}_i^t$ such that consumers stop buying even though the maximization of (1) would lead to positive purchases at this price. This consumer reaction can be justified by supposing that consumers actually maximize a utility function that is more elaborate than (1) and that this utility function takes into account consumer’s perception of the extent to which producers are generous towards consumers. Consumers want their sellers to feel altruism towards them and expect firm $i$ to set prices so as to maximize

$$w_i^t + \lambda^i \int_{j \neq i} (w_i^t - w_{0i}), $$

(3)

where $\lambda^i$ is a measure of producer $i$’s altruism while $w_{0i}$ can be thought of as a base level of household $j$’s utility (which may, for example, involve no consumption of good $i$). To simplify the discussion of the one-period model, suppose that the producer’s expenditure on goods at $t$ equals his revenue from sales (so that $E_i^t = P_i^jy_i^t$) though this assumption is dropped in the multi-period model below. Since the derivative of $w_i^t$ with respect to $P_i^j$ equals $u'(C_i^t)c_i^t(j)/P_t$, the maximization of (3) would lead to a price that satisfies

$$(1 - \theta) \frac{E_i^t u'(C_i^t)}{P_t} \left( \frac{P_i^j}{P_t} \right)^{-\theta} + \theta \frac{E_i^t \phi_i^ ty_i^t u'(C_i^t)}{P_t} \left( \frac{P_i^j}{P_t} \right)^{-\theta-1} - \lambda \int_{j \neq i} \frac{E_i^t u'(C_i^t)}{P_t} \left( \frac{P_i^j}{P_t} \right)^{-\theta} = 0. $$

Not surprisingly, a higher value of $\lambda$ leads to a lower price while a higher value of the cost indicator $\phi_i^t$ leads to a higher one. In a symmetric equilibrium where all
households have the same $u'$, the optimal price satisfies

$$\frac{P^i_t}{P_t} = \frac{\theta \phi^i_t}{\theta + \lambda - 1} \frac{v'}{u'}$$

(4)

This price is well defined even if $\theta < 1$ as long as $\lambda + \theta > 1$. In the extreme case where $\lambda = 1$, this price implements the first best outcome.

Consumers do not know the costs or the $\lambda$ of their suppliers. However, if the information available to consumers allows them to reject the null hypothesis that the $\lambda$ of a producer is at least equal to $\bar{\lambda}$, consumers stop purchasing from this producer. In effect, household $j$ chooses his consumption basket by maximizing

$$u(C^j_t) - \int_{i \neq j} \lambda_c \psi(\hat{\lambda}_c)(w^j_i - \bar{w}^j_i),$$

(5)

where $\bar{w}^j_i$ is the value of $w^j_i$ without the consumer’s purchase, $\lambda_c$ is an arbitrarily large number and $\psi$ is a step function which equals zero if the consumer cannot reject the hypothesis that firm $i$’s $\lambda$ equals at least $\bar{\lambda}$ against the alternative that it is smaller. If, instead, consumers are able to reject the hypothesis that $\lambda^j_i = \bar{\lambda}$, then the function $\psi$ equals one. Since consumers believe that producers set prices according to (4), the hypothesis they are testing is the hypothesis that the firm’s marginal cost implied by (4) with a $\lambda = \bar{\lambda}$ is consistent with the consumers’ subjective distribution concerning this costs. This hypothesis is rejected if the producer’s price is above some critical level, because this would require that the producers’ costs be implausibly large.

This model of consumer behavior, with its assumption that consumers want to harm firms that treat them unfairly, is closely related to Rabin (1993). His model of fairness involves three key ingredients. These are a definition of “kindness”, a definition of “equitable payoffs” and a specification of preferences that depend on both one’s own kindness and the kindness one expects from the person one is dealing with. He measures the expected kindness of the second player towards the first by the difference between the payoffs that the first expects to receive from the second and the payoffs that it would “equitable” for the second to give to the first. He then defines equitable payoffs as being equal to the average of the highest and the lowest payoffs the second agent can give to the first under the assumption that the player acts efficiently. Lastly, he supposes that agents maximize the sum of their own material payoffs and the product of their own kindness times the kindness they expect to receive from the other agent. Thus, if the first agent expects the second to give the first a payoff that is higher than the “equitable” payoff, the first agent seeks to raise the second agent’s payoff above that agent’s equitable payoff.9

8In this paper, I consider only altruism of the firm towards consumers. However, corporations also seek to appear “corporately responsible” by engaging in charitable activities. Moreover Campbell (1999) provides questionnaire evidence that people’s perception of the fairness of raising the price of a doll whose demand is high just before Christmas depends on whether the proceeds will go to charity or whether they will be kept by the store. Thus, consumers may also refrain from punishing firms that are altruistic towards people other than the consumers themselves.

While this approach to fairness is quite similar to Rabin’s (1993) in its use of a psychological utility function that seeks to reward like with like, there are some differences in the two specifications. From the point of view of generating price rigidity, one of the key differences is the supposition that the psychological utility function is highly nonlinear. In this model, consumers have a neutral attitude towards firm profits in a broad set of circumstances. Positive utility for punishing a firm arises only if consumers feel the firm has behaved in a demonstrably egregious manner. This specification predicts that consumer reactions will be subject to threshold effects, where consumers react only to what they perceive to be extreme cases. When they do react, on the other hand, their reactions are strong. Casual observation suggests that this fits the reactions of consumers somewhat better than the supposition that consumers react in a “continuous” way to bad behavior by the firm. It is much more common to hear calls for complete boycotts than calls for small reductions in the purchases from particular firms, for example.

A second difference with Rabin’s (1993) analysis is that he supposes that each player knows both the preferences and the opportunities available to the other. In the case of consumers, it is not plausible to suppose that their information regarding their supplier’s circumstances is very good. I have thus cast the analysis in parametric terms, consumers use their information to estimate and test hypotheses about the value of one parameter. The use of an altruism parameter seems particularly straightforward and has the advantage that the parameter remains meaningful even if very little is known about the firm.

If all consumers have the same information, this specification implies that there is a price for each firm, $\bar{P}_t^i$ such that consumers do not purchase if firm $i$’s price is above $\bar{P}_t^i$. Suppose that this leads the producer not to purchase or produce and that $u(0) = v(0) = 0$. Let producers have a p.d.f. over $\bar{P}_t^i$ given by $G$. This p.d.f. is a step function if the firm knows the true value of $\bar{P}_t^i$. The analysis is somewhat simplified by supposing that producers are, in fact, selfish. Thus $P_t^i$ maximizes

$$\begin{align*}
1 - G(P_t^i) &\left[ u\left( E_t \left( \frac{P_t^i}{P_t} \right)^{-\theta-1} \right) - v\left( \phi_t E_t \left( \frac{P_t^i}{P_t} \right)^{-\theta} \right) \right].
\end{align*}$$

The first order condition for this problem is

$$\begin{align*}
1 - G(P_t^i) &\left[ E_t \left( \frac{P_t^i}{P_t} \right)^{-\theta-1} \right] \left\{ (1 - \theta)u' \left( \frac{P_t^i}{P_t} \right) + \theta \phi_t v' \right\} \\
- g(P) &\left[ u\left( E_t \left( \frac{P_t^i}{P_t} \right)^{-\theta-1} \right) - v\left( \phi_t E_t \left( \frac{P_t^i}{P_t} \right)^{-\theta} \right) \right] \leq 0.
\end{align*}$$

When the price $P^*$ that makes the expression in curly brackets equal to zero has the property that $G(P^*) = 0$, the solution to this first order condition is to set $P_t^i = P^*$.

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10Letting producers have a positive $\lambda$ complicates the algebra but does not change the analysis appreciably. A more elaborate extension would have consumers test the hypothesis that producers’ equal $\lambda$ taking into account that producers are second-guessing the price that would lead consumers to stop making purchases. The structure of the model would then be more similar to that of signaling models.
Otherwise the optimal price is lower than $P^*$ and there are two cases to consider. In the first, the price $P_t^*$ that maximizes (6) is interior so that (7) is satisfied as an equality at this price. In the second, the price that maximizes (6) is the price $\hat{P}$ that satisfies $G(\hat{P}) = 0$ and thus guarantees that consumers regard this price as fair. This second solution applies when $g(\hat{P})$ is sufficiently large that (7) holds as an inequality at $\hat{P}$. In this case, the firm charges $\hat{P}$ because there is a large kink in the demand curve at this price.\(^{11}\)

This model can justify price rigidity from one period to the next even if one supposes that the optimum is of this last type (perhaps because $G$ is a step function at $\hat{P}$). However, one would then have to imagine that $\hat{P}$ is perfectly rigid over time. Since consumers are bombarded with information about the economy on a daily basis, it is more attractive to suppose that they do update their distribution of producer costs from one day to the next.

A more plausible model of price rigidity follows from assuming that consumers do not revise their opinion about the firm’s altruism until the firm changes its price. While I do not derive conditions under which this is optimal for consumers, it fits with Kahneman et al. (1986) who suppose that an action is regarded as fair if it is better, or at least not worse than a reference action. For the most part, like Rabin (1993), they see actions as fair if they somehow balance the interests of the two parties. But, Kahneman et al. (1986) also assert that reference actions are often dictated by the past. According to them, changes in conditions including reductions in wages and increases in prices are regarded as unfair unless it is common knowledge that the firm who imposes these changes would suffer greatly without taking these actions.

One reason why consumers may not revise the fairness of the prices they pay if these are identical in nominal terms to those that they have paid in the past is that this rule of thumb saves on costs of computation. Moreover, in the presence of a positive level of trend inflation firms that keep their nominal prices constant at $t$ do tend to offer consumers a better deal than they did at $t - 1$. Thus, this rule of thumb may not be very costly to consumers. A second reason for consumers to refrain from re-evaluating the fairness of a firm’s price when this price remains constant is that consumers may believe the firm has large administrative costs of changing prices. If consumers had such a belief, they would not change their estimate of $\lambda_f$ even if the firm kept its price constant under a broad range of circumstances.

Suppose that economic conditions change from $t - 1$ to $t$, so the firm contemplates a change in its price. There are now two illuminating extreme cases to consider. In the first, consumers have no memory of past costs. Thus, they can only compare their current subjective p.d.f. of costs to the current price as above. Knowledge of the past price may be helpful to consumers in this setting, but only insofar as it contains information about the firm’s current costs.

\(^{11}\)The optimization problem of a firm setting a new price is then very similar to the optimization considered in Sibly (2002) for the case where consumers are “loss averse.” He uses this term to describe settings where the slope of consumers’ demand curve is discontinuous at a “reference price.”
If $P^*$ satisfies (7) because $G(P^*) = 0$, the firm chooses its first best action in spite of the customers scrutiny of the firm’s altruism. Indeed, in this case, there is no reason for the firm to choose to repeat its earlier price. Now suppose that $G(P^*) > 0$. The firm now keeps its price equal to $P_{t-1}$, its price in the previous period, if the price that maximizes (6) (which is below $P^*$) is lower than $P_{t-1}$. Keeping the price constant leads to a price which is closer to the firm’s unconstrained optimum without creating any risk of customer complaints.

This benefit of constant prices can lead firms to increase prices only in those periods where consumers have a particularly generous estimate of the firm’s costs, and this motivation for price rigidity lies at the basis for the multi-period model below. This logic can explain downwards price rigidity in response to falls in cost even when consumers are relatively well informed because the resulting high profits are not visible enough to lead to complaints. Even if consumers were unaware of cost changes, prices would fall if costs fell so much that the price that maximizes the objective function $w_t^i$ also satisfies (7). Even so, the fall in prices would be less than proportional to the fall in costs even if the elasticity of demand were constant.\textsuperscript{12}

Suppose that, instead, the price that maximizes (6) is above $P_{t-1}$, so that prices would be expected to rise. If the price that maximizes (6) is $\bar{P}$ such that $G(\bar{P}) = 0$, the firm should increase its price. The reason is that it thereby increases the value of its objective function without increasing the probability of a consumer revolt. In this case the price is not rigid in the sense of staying constant.

On the other hand, keeping the price constant is good for the firm if the optimum is interior and the price that satisfies (7), is sufficiently close to $P_{t-1}$. By keeping the price constant, the producer gets $u(P_{t-1}) - v(P_{t-1})$ while he gets $[1 - G(P_{t}^i)][u(P_{t}^i) - v(P_{t}^i)]$ if he raises it to $P_{t}^i$. Since $G(P_{t}^i) > 0$ the latter can be less than the former. Thus, fear of consumer re-evaluation of the firm’s fairness can act as a “fixed” cost of price changes that keeps firm prices constant. What makes the model differ from one with a simple fixed cost, however, is that the magnitude of the price change matters as well. This fits with the evidence of Zbaracki et al. (2004) who report that salesmen are much more worried about negative reactions to large price increases than they are about small ones.

Consumers are particularly likely to react to large price changes, as opposed to high levels of prices if they have a diffuse prior about the level of costs but have a more precise estimate of the percent change in marginal cost from $t - 1$ to $t$. For a given elasticity of demand, consumers expect prices to rise by the same percent change as marginal cost regardless of the level of firm altruism. Increases in price that do not correspond closely to increases in costs are likely to trigger consumer anger. Supposing once again that consumers only compute whether the firm is being fair when the firm changes its prices, the firm will tend to keep its price constant if its optimal price at $t$, $P_{t}^i$ is both interior and close to its inherited price $P_{t-1}$.

\textsuperscript{12}This logic might explain the widening of profit margins for U.S. coffee distributors as the wholesale price of coffee fell dramatically between 1997 and 2002. See Wall Street Journal, July 8, 2002 for a brief discussion of the relevant facts.
4. A multi-period general equilibrium model

This section extends the model to a dynamic setting, while considering only a very simplified structure for the information available to consumers and firms. Household \( i \)'s material payoffs, i.e. his utility function at \( t \) in the absence of fairness concerns is now given by

\[
E_0 \sum_{t=0}^{\infty} \beta^t w_t^i. 
\]

(8)

Suppose that there are full insurance markets against idiosyncratic risks while firms have enough information to avoid angering their customers (so this event is not covered by insurance). Each individual's consumption at \( t \) is then a fixed fraction of aggregate consumption \( Y_t \) (which in turn equals \( E_t(Y_t) \)). With ex ante identical households, this means that the equilibrium value for \( u' \) is the same for all of them. In addition to having access to a full set of insurance markets, households can borrow and lend at the riskless nominal rate \( R_t \). This means that they must be indifferent between consuming an additional unit of consumption at \( t \) and expecting to consume \( (1 + R_t)P_t/P_{t+1} \) additional units of consumption at \( t + 1 \). Thus

\[
E_t \left\{ \frac{\beta(1 + R_t)P_t u'(Y_{t+1})}{P_{t+1}} \right\} = u'(Y_t). 
\]

(9)

Consider a setting where the beliefs of consumers about what constitutes fair pricing for any given firm evolve stochastically from period to period and from firm to firm even though all firms are identical. At any given time, consumers believe that the cost of any particular firm are either high (with \( \phi_t^i = \Phi_t^H \)) or low (with \( \phi_t^i = \Phi_t^L < \Phi_t^H \)). In addition, consumers observe signals equal to \( \hat{\phi}_t^i \) for each firm. These signals are drawn independently across firms from the p.d.f. \( F_t(\hat{\phi}) \). Households view this signal as being equal to the true value of \( \phi_t^i \) (which they see as being either \( \Phi_t^H \) or \( \Phi_t^L \)) plus a random measurement error \( z \) which is drawn from the p.d.f. \( H(z) \). Thus, the consumers' subjective probability that the firm has a cost parameter \( \Phi_t^H \) given a signal equal to \( \hat{\phi}_t^i \) or lower equals \( H(\hat{\phi}_t^i - \Phi_t^H) \).

As before, a firm which keeps its price constant does not face a re-evaluation of its fairness. With a sufficiently large level of steady state inflation, firms do not ever find it optimal to lower their prices in this setting. It is then unimportant to understand how consumers react to price decreases.\(^{13}\)

\(^{13}\)In the absence of such steady state inflation, price decreases are sometimes optimal. One might, however, be able to reduce the incidence of such price declines by supposing that even price declines lead consumers to re-evaluate the fairness of a firm’s prices.
previous period. Under the hypothesis that $\phi^i_t$ equals $\Phi^i_H$, by contrast a firm can raise its price with impunity as long as

$$P^i_t \leq P_t \frac{\partial \Phi^H_t}{\partial H} v'.$$

(10)

Consider then a firm that changes its price and keeps it below this upper bound. Since the probability of receiving a signal as unfavorable as $\Phi^i_t$ given that the firm’s cost parameter is $\Phi^H_t$ equals $H(\Phi^i_t - \Phi^H_t)$, consumers will reject the hypothesis that this firm’s altruism parameter equals at least $\tilde{\gamma}$ if

$$H(\Phi^i_t - \Phi^H_t) < \gamma,$$

(11)

where $\gamma$ is the size of the test used by consumers. Firms whose $\hat{\Phi}^i_t$ is lower than the critical value of this test are better off keeping their price unchanged. To simplify the analysis, suppose that firms know the value of $\hat{\Phi}^i_t$. They thus keep their prices constant with probability $a_t$, which is given by

$$a_t = F_t(H^{-1}(\gamma) + \Phi^H_t).$$

(12)

If $F_t$ and $\Phi^H_t$ are constant over time, this model is thus equivalent to the Calvo (1983) model where the probability of changing prices is constant. This model is easier to analyze in the case where producers can charge any price they wish whenever (11) is violated. The conditions under which this is valid are derived below. Given full insurance markets, a one dollar increase in profits in period $t + j$ raises expected utility at $t$ by $E_t b' Y_t^j / P_t^j$. Thus, the optimal price maximizes

$$E_t \sum_{j=0}^{\infty} b^j \left( \prod_{t=1}^{j} \frac{\alpha_{t+\ell}}{\alpha_{t+\ell}} \right) \left( Y_{t+j} \left( \frac{P^i_t}{P_{t+j}} \right)^{\theta - 1} \right) - v \left( Y_{t+j} \left( \frac{P^i_t}{P_{t+j}} \right)^{-\theta} \right)$$

(13)

over $P^i_t$. The first order condition for this problem is

$$E_t \sum_{j=0}^{\infty} b^j \left( \prod_{t=1}^{j} \alpha_{t+\ell} \right) \left( Y_{t+j} \left( \frac{P^i_t}{P_{t+j}} \right)^{\theta - 1} \right) - \theta v' \left( Y_{t+j} \left( \frac{P^i_t}{P_{t+j}} \right)^{-\theta} \right) = 0.$$

Consider the case where $u'(c)$ equals $u_0 c^{-\sigma}$ while $v'(y)$ is proportional to $v_0 y^\sigma$. Letting $X_t$ denote the relative price of price changers and dividing through by $(P^i_t/P_1)^{\theta}$,

$$X_t^{1+\theta\sigma} = \frac{\theta v_0 / u_0}{1 - \theta} \frac{E_t \sum_{j=0}^{\infty} b^j \left( \prod_{t=1}^{j} \alpha_{t+\ell} \right) (1 + \pi_{t+\ell})^{\theta(1+\omega)} Y_{t+j}^{1+\sigma}}{E_t \sum_{j=0}^{\infty} b^j \left( \prod_{t=1}^{j} \alpha_{t+\ell} \right) (1 + \pi_{t+\ell})^{\theta(1-1)} Y_{t+j}^{1-\sigma}},$$

(14)

where $\pi_t = (P_t - P_{t-1})/P_{t-1}$. If $\Phi^H_t$ is sufficiently large, this value of $X_t$, satisfies (10). Thus, firms whose $\Phi^i_t$ is sufficiently large to change prices, set their price according to (14).
Given the common choice of $P_t^t / P_t$, (2) implies

\[ (1 - \alpha_t)X_t^{1-\theta} + \alpha_t \left( \frac{P_{t-1}}{P_t} \right)^{1-\theta} \right]^{1/(1-\theta)} = 1. \]  

(15)

In a steady state with constant inflation $\pi$, and constant probability of changing prices $\alpha$ this implies

\[ (1 - \alpha)X^{1-\theta} + \alpha(1 + \pi)^{\theta-1} = 1. \]  

(16)

With positive inflation, the relative price of each price setter declines until he is again able to set his relative price to $X$. Let $\tilde{x}_t$, $\tilde{y}_t$, $\tilde{z}_t$ and $\tilde{p}_t$ denote the logarithmic deviations from their steady state values of $X$, $Y$, $\alpha$ and $1 + \pi$, respectively.

Supposing that the equilibrium remains near a steady state, one can describe its properties by differentiating (15), and using (16) to substitute for the steady state value of $X$,

\[ \tilde{\pi}_t = \frac{1 - \alpha(1 + \pi)^{\theta-1}}{\alpha(1 + \pi)^{\theta-1}} \tilde{x}_t + \frac{(1 + \pi)^{1-\theta} - 1}{(1 - \alpha)(\theta - 1)} \tilde{z}_t. \]  

(17)

Using $L$ to denote the lag operator and differentiating (14),

\[ (1 + \theta \omega) \tilde{x}_t = E_t \frac{1}{1 - \lambda_1 / L} (c_2^y \tilde{y}_t + \lambda_1 \tilde{z}_{t+1} + \lambda_1 \theta(1 + \omega) \tilde{\pi}_{t+1}) \]

\[ + E_t \frac{1}{1 - \lambda_2 / L} (c_2^y \tilde{y}_t - \lambda_2 \tilde{z}_{t+1} - \lambda_2 (\theta - 1) \tilde{\pi}_{t+1}), \]

\[ \lambda_1 \equiv \alpha \beta (1 + \pi)^{\theta(1+\omega)}, \quad \lambda_2 \equiv \alpha \beta (1 + \pi)^{\theta-1}, \quad c_1^y \equiv (1 + \omega)(1 - \lambda_1), \]

\[ c_2^y \equiv (\sigma - 1)(1 - \lambda_2). \]  

(18)

When the steady state rate of inflation $\pi$ equals zero, the coefficient of $\tilde{x}$ in (17) equals zero. In addition, $\lambda_1 = \lambda_2 = \alpha \beta$ in this case, so that the coefficient of $\tilde{z}$ in (18) is zero as well. Thus small variations in $\alpha$ have no effect on economic outcomes. The reason is that, with zero steady state inflation, the steady state value of $X$ is 1.00 so that each firm’s average price change equals zero. Thus, an increase in the number of price changers does not typically affect the price level. When inflation is positive, by contrast, $X > 1$ and the typical price changer raises his price. While the effect of changes in $\alpha$ is necessarily small for $\pi$ sufficiently small, the analysis below shows that the effect of small variations in $\tilde{x}$ can be significant even if steady state inflation is equal to just 5% per year.

The computation of deviations from the steady state equilibrium require also the linearization of (9) as well as a linearized reaction function for the central bank. For purposes of illustration, suppose that the latter is given by

\[ \tilde{I}_t = c_2^b \tilde{x}_t + c_1^b \tilde{I}_{t-1} + \tilde{e}_t. \]  

(19)

The object of the next section is to analyze the response of the economy to monetary policy shocks $c_2^b$. While this is only meant to be illustrative, it uses parameter values that are similar to those in the literature. In particular, $\beta$ is set to
.99, \( \sigma = 1 \) while \( \theta \) and \( \omega \) equal 7.88 and .47, respectively, as in Rotemberg and Woodford (1997). While the analysis focuses on an annual inflation equals 5\%, the case of 50\% inflation provides a useful comparison.

As when there are fixed costs of changing prices, one would expect price adjustment to be more frequent when inflation is more rapid. On the other hand, fixed costs of changing prices also imply that the departure of the reset price from the average price (i.e. \( X \)) is larger when inflation is larger, and this is consistent with the experience of high inflation countries. I thus suppose that, when annual inflation equals 5\%, the typical price-changing firm sets a price 5\% above that of its peers so that the steady state value of \( X \) equals 1.05. The typical price changer is then raising his price by \( P_t^d/P_{t-1} \), or \( X(1 + \pi) \), which equals 6.3\%. Using (16), this value of \( X \) implies that firms adjust their prices on average once a year and \( \alpha \) equals .76. By contrast, when annual inflation equals 50\%, I suppose \( X = 1.06 \) and the resulting value of \( \alpha \) is only .25. Aside from the consistency with models of fixed costs of changing prices, Bakhshi et al. (2003) report that having \( \alpha \) fall relatively rapidly with inflation is necessary to ensure that output does not become excessively sensitive to inflation as steady state inflation rises.

Let the two parameters of the monetary policy rule, \( c^{\pi}_1 \) and \( c^{\pi}_1 \), be equal .9. These high values ensure both that the \( c^{\pi}_1 \) shock has persistent effects and that the equilibrium is determinate. It turns out that the conditions for determinacy are substantially more stringent when the equilibrium is approximated around a steady state with positive inflation then when it is approximated around one with zero inflation, as is more standard. In the standard case, discussed for example in Woodford (2003), determinacy obtains even with \( c^{\pi}_1 = 0 \) as long as \( c^{\pi}_1 \geq 1 \). By contrast, if \( c^{\pi}_1 = 0 \), determinacy when \( \pi = .05 \) requires that \( c^{\pi}_1 \) be no smaller than 2.8.14

5. Monetary policy

Fig. 2 illustrates a standard result, namely that when \( \pi \) is constant, the drop in inflation is largest in the quarter where interest rates first increase. This pattern of responses of inflation to monetary policy shocks differs from estimated responses because, in the latter, the largest reduction in inflation takes place sometime after the monetary policy shock. Rotemberg and Woodford (1997) find that the biggest response takes place after two quarters. Other studies find longer delays, with Christiano et al. (2005) reporting a maximum response after 9 quarters.

In an important extension of the Calvo (1983) model, Dotsey et al. (1999) maintain the assumption that costs of changing prices are independently distributed over time for each individual firm but relax the assumption that these costs are drawn from a two point distribution where the costs are either negligible or prohibitive. Instead, they let the costs be drawn from a compact set. When a firm faces the lowest possible cost of changing prices, it is quite likely to adjust its price. It

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14This substantial quantitative difference has been found independently in Kiley (2004).
is less likely to do so if this realized cost is somewhat higher because it is then
tempted to wait in the hope that future costs will be lower. On the other hand, a firm
will change its price even if its realized cost is relatively high as long as its existing
price is sufficiently far from the optimal one.

Unfortunately, this modification appears to exacerbate the tendency for inflation
to fall immediately when interest rates are increased.\textsuperscript{15} The reason is that, in an
environment with positive steady state inflation, a reduction in future inflation
means that the prices that maximize profits in the future are now closer to $P_t$ itself.
This is reflected in the fall in $X_t$ at the moment that $\delta^t_i$ rises. Because an increase in $\delta^t_i$
leads firms that change prices to raise them by less, the payoff from adjusting prices
falls relative to the payoff of doing nothing. With a compact set of realizations for
the cost of changing prices, this reduces the fraction of firms that adjust their prices
at $t$. Since the typical price-adjusting firm is actually increasing its price, this
reduction in the fraction of firms that adjust their price lowers inflation at $t$ even
further.

\textsuperscript{15}They carry out their analysis by considering changes in the growth of the money supply. However, the
logic of their analysis ought to carry over to monetary policy reaction functions like (19).
If, instead, price rigidity is due to fear of customer reactions rather than to fixed costs of changing prices, rather different patterns of responses are possible. In particular, one would expect that the reduction in $X_t$ induced by a contractionary monetary policy would make it easier for firms to raise their prices so that they charge their desired price. Thus, if consumers react to the price charged by price changers, more firms might be willing to change their price after a monetary contraction.

A small modification of the earlier analysis produces this result. Suppose, in particular, that consumers do not know the value of $F_h$. It would then be natural to infer this value from the prices charged by those firms whose $\phi_i$ is high since these firms are not constrained by the possibility of consumer anger. Since these unconstrained firms all choose the same $X_t$, it seems reasonable for consumers to treat them as having the expected level of altruism $\bar{\lambda}$. Using (4), then provides an estimate of $\Phi^H_t$, namely

$$\Phi^H_t = \frac{\theta + \bar{\lambda} - 1}{\theta} u'(X_t).$$

(20)

A higher value of $X_t$ raises the estimate of $\Phi^H_t$ since it suggests that the costs of legitimate price changers are higher. Eq. (12) then implies that the fraction of firms that keep their price constant rises because, as can be seen from (11), only firms with higher values of $\phi^i_t$ can raise their price with impunity.

A second plausible determinant of $\alpha_t$ is the rate of inflation at $t$. It seems reasonable to suppose that a higher inflation rate leads consumers to be more willing to countenance price increases. A crude method for capturing this is to suppose that the distribution $F$ shifts to the right when $\pi_t$ is higher, so that consumers tend to draw higher values of $\phi^i_t$. Such a shift to a stochastically dominant distribution implies that the probability of realizations below $(H^{-1}(\gamma) + \Phi^H_t)$ falls. Eq. (12) then implies a reduction in $\alpha_t$. These effects can, to first order, be captured by the linearized equation

$$\tilde{\alpha}_t = c^\alpha_X \tilde{X}_t + c^\alpha_\pi \tilde{\pi}_{t-1},$$

(21)

where $c^\alpha_X$ is positive while $c^\alpha_\pi$ is negative.

Fig. 2 also reports responses when $\tilde{\alpha}$ is given by (21) with $c^\alpha_X = 2.5$ and $c^\alpha_\pi = -15.16$. These parameters are such that $\alpha_t$ initially falls (because $X_t$ falls) and then rises (because inflation falls). The result is that, when the annual steady state inflation rate is 5%, inflation has its lowest point two quarters after the monetary shock. Moreover, the fall in inflation is much smaller in the initial quarter than when $\alpha$ is fixed. In the latter case, inflation falls by about .18% with an initial increase in the rate of interest of .88%. By contrast, when $\alpha$ is given by (21), inflation falls initially by only .06% even though the interest rate rises by .95%. This difference obtains even though the fraction of firms keeping their price constant falls by only about 1.8%. Since firms who adjust their price in steady state do so by about 6.3%, having

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16I have also considered specifications with $c^\alpha_\pi = 0$. Unfortunately, these specifications also imply that the largest fall in inflation occurs in the quarter of the monetary policy shock.
1.8% more of them do so raises inflation by about .11% so this does not fully account for the difference in inflation responses. The rest is accounted for by the fact that $X_t$ falls more when $z$ is constant. This occurs because, with variable $z$, firms who adjust their price realize that price adjustments will become more infrequent in the future (because the reduction in inflation will push up $z_{t+j}$). Given the existence of underlying inflation, this leads them to charge slightly higher prices at $t$.

Interestingly, neither the path of output nor that of interest rates is significantly affected by these changed dynamics of inflation. The lack of monotonicity in the inflation response means that the real rate rises less initially but stays higher for a longer period of time when $z$ is variable. The real rate of interest on a long term bond, which determines the initial response of output, is similar in both cases.

Results are qualitatively similar when the steady state annual inflation rate is 50% and $c^* = -10$. Inflation falls much less on impact than with a fixed $z$ and it reaches its lowest point in the second quarter rather than the first. The reason the decline in inflation is much smaller even though $z_t$ falls by less than one percent is that the typical price changer is now changing prices by 17.3% so that having 1% more price changers raises inflation by .17%. The result of this modest fall in inflation is that, compared with keeping $z$ constant, interest rates fall back more slowly so that output falls significantly more. This result is attractive because the frequency of price adjustment is high when inflation is high, so that a model with fixed frequency of price adjustment would appear to have difficulty predicting large output responses to monetary policy in inflationary environments. Yet, stabilizations in high inflation countries often do involve substantial losses in output.

Because the model of endogenous variations in $z$ is only tentative, it is worthwhile to carry out some calculations treating $z$ as exogenous. This involves looking at the impulse responses of output, inflation and interest rates to monetary shocks by considering what seem a priori plausible responses of $z_t$. Note that variations in $z_t$ ought in principle to be observable. Thus, a more ambitious research agenda would analyze how the rest of the economy ought to react given the actual responses of the fraction of firms changing prices. It would then proceed also to try to explain the actual movement in the fraction of price changers.

Before carrying out this analysis, it is worth giving one additional reason for $z$ to fall in the immediate aftermath of a monetary contraction. Such a contraction ought to lead sophisticated price setters to realize that inflation will slow so that price increases will become more difficult to “sell” in the future. This ought to lead some firms that would have kept their prices constant in the absence of the tightening to raise prices and thereby increase the risk of contemporaneous negative reactions by customers. The advantage of doing so is that price setters can still point to past inflation as a reason for the price increase while this will become harder in the future. Unfortunately, this mechanism does not fit into the model developed so far because, for simplicity, firms kept the probability of negative reactions equal to zero. By contrast, the mechanism I just suggested requires that firms be willing to increase this probability above zero under some circumstances.
Suppose that the pattern of exogenous responses of $z_t$ is given by

$$\tilde{z}_t = 1.02\tilde{z}_{t-1} - .116\tilde{z}_{t-2} - .302\tilde{z}_{t-3} - c^e \epsilon_t.$$  \hspace{1cm} (22)

As depicted in Fig. 3, this implies that a monetary contraction first raises the fraction of price adjusters and, after a few quarters, lowers this fraction below its steady state value. This pattern would be reasonable if a contractionary shock reduced inflation only after several quarters, because this would justify both the initial rush of price adjustments and the subsequent reduction in the fraction of adjusters. The initial rush could then be due either to the reduction in $X_t$ or to the desire to raise prices while one can still point to a recent episode of relatively high inflation.

With $c^e$ set equal to 3, the resulting responses of output, inflation and interest rates are plotted in Fig. 3 as well. The Figure shows that the response of inflation is indeed delayed for several quarters, and inflation reaches its minimum 6 quarters after the initial burst of interest rates. Thus, the responses of $z$ in (22) seem to yield a pattern of inflation responses (where inflation at first does little even though $X$ falls and then inflation later declines) which makes the responses assumed in (22) reasonable. It is worth noting, however, that these responses of $z$ are substantially larger in absolute magnitude than the responses of inflation. It remains unclear whether such a
difference in the size of these responses is justifiable through an explicit model of consumer behavior.

Because inflation responds so modestly, (19) implies a slow return of interest rates to their steady state value. This means that real interest rates stay high for some time and that the output drop is considerable. Such large output declines are not particularly realistic but the exercise does show that a contractionary monetary policy with long lived output effects is perfectly consistent with muted and delayed responses of inflation.

An obviously unrealistic feature of these responses is that output has its biggest fall instantaneously. To account for gradual reductions in output the model has to be modified either by adding decision lags (as in Rotemberg and Woodford, 1997) or by changing the specification of preferences so consumers try to smooth output changes. As suggested by Fuhrer (2000), one way of obtaining “hump shaped” responses of output in monetary models of this type is to suppose that consumers have preferences that can be characterized by “habit persistence”. It is thus worthwhile to consider briefly a modification of the model along these lines.

Let $\bar{C}_t$ represent the “habit” and specialize the utility from consumption so that

$$E_0 \sum_{t=0}^{\infty} \beta^t \left[ \frac{(C_t^{\psi})^{1-\sigma}}{(1-\sigma)C_t^{\psi}} - v(y_t^{\psi}) \right].$$

Following Abel (1990), let this habit be external to the individual. Specifically, suppose that $\bar{C}_t = Y_{t-1}^{\psi}$. The case $\psi = 0$ corresponds to the utility function used so far.

The consumer must still be indifferent to consuming one less dollar at $t$ and consuming the proceeds from investing this dollar in a nominal asset yielding $R_t$ at $t+1$. This now requires that

$$E_t \beta(1 + R_t)P_t Y_{t-1}^{\psi} C_{t+1}^{-\sigma} = 0.$$

This change in the utility function also affects the value of marginal utility in (13). Using $Y_{t-\sigma}^{\psi} / Y_{t-1}^{\psi}$ for this marginal utility, (14) becomes

$$X_t^{1+\theta \omega} = \frac{\theta v_{\omega}}{u_{\omega}} \frac{E_t \sum_{j=0}^{\infty} \beta^j (\prod_{t=1}^{j+\omega} (1 + \pi_{t+\omega})^{\theta(1+\omega)}) Y_{t+j}^{1+\omega} Y_{t+j-1}^{-\psi}}{1 - \theta E_t \sum_{j=0}^{\infty} \beta^j (\prod_{t=1}^{j} (1 + \pi_{t+j})^{\theta - 1}) Y_{t+j}^{1-\sigma} Y_{t+j-1}^{-\psi}}.$$

To compute impulse responses, (18) must be modified accordingly. The responses for $\psi = -0.7$ are plotted in Fig. 4, which also shows the responses for constant $\omega$ as a benchmark. When comparing Figs. 3 and 4 for the case of constant $\omega$, one sees that the higher value of $\psi$ does induce a hump-shaped response of output. In addition, the effect of the monetary disturbance on inflation rises, particularly relative to the response of output. With $\omega = 3$, on the other hand, the response of output to the monetary disturbance is quite large, though it remains hump-shaped. The reason, in part, is that the resulting swings in $\omega$ are large enough to mute considerably the
initial response of inflation. This means that the real interest rate rises a great deal and this induces large swings in output.

Fig. 4 thus shows that hump shaped responses of output together with modest inflation responses are not at all inconsistent with the model as long as \( \alpha \) varies in the requisite ways. The qualitative features of the required response of \( \alpha \) remain intuitively appealing. Whether the actual magnitude of this response is either empirically valid and whether it can be derived from a quantitative model of consumer behavior remain open questions for research.

6. Conclusions

This paper has shown that the threat of consumer anger can account for the constancy of prices from one period to the next while also having the potential to explain some of the dynamic responses of the economy to monetary policy shocks. The consumer reactions in the model are “irrational” in the sense that consumers are maximizing something other than a utility function that depends only on their own material payoffs. Rather, they also wish to harm (or at least not to help) firms that
they see as having given them a bad deal. Understandably, this leads firms to be careful not to induce these emotional reactions.

One attraction of modelling price rigidity as stemming from consumer reactions is that this provides a new mechanism through which lack of information about economic conditions translates into muted price responses. It is easy to believe that consumers are poorly informed about cost changes and this may lead firms that are concerned with consumer reactions to make their prices less sensitive to costs. By contrast, more standard models in which poor information leads to sluggish price adjustment suppose directly that producers are imperfectly informed about either costs or demand. Given the huge incentives for producers to acquire all relevant information and given that a small number of sophisticated individuals makes the bulk of the economy’s pricing decisions, this approach seems less attractive.

Heterogeneity in information sets ought not to be confined to differences between producers and consumers. Consumers, in particular, are likely to differ a great deal from each other in both their information and their attitude towards suppliers. Nonetheless, anger at producers appears to be communicable and this seems capable of leading to the sort of discontinuous change in purchases considered in this paper. Thus, information transmission from one set of consumers to another, particularly in situations where some consumers feel that the firm has stepped over the line, seems to be important in practice. Modelling this information transmission thus remains an important topic for future research.

Another attractive modification would involve allowing consumers to be more aware of the actual problems faced by producers. In the current model, consumers have a theory about how “fair” producers behave and producers take this theory into account when setting prices. While inherently plausible, the theory that consumers have about producer behavior does not correspond as closely as seems desirable to the way the producers actually behave in the model. In particular, it would be attractive to let consumers recognize that producers solve a dynamic model when they set prices.

References