Price Setting in Forward-Looking Customer Markets

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First Draft: February 16, 2005

This Version: September 5, 2005

Abstract

We propose a new explanation for price rigidity. We show that if consumers form habits in individual goods, then firms face a time-inconsistency problem. The consumers' habits imply that low prices in the future help attract customers in the present. Firms would therefore like to promise low prices in the future. But when the future arrives they have an incentive to exploit consumers' habits and price gouge. In this model, unlike the standard no-habit model, nominal price rigidity is an equilibrium outcome. Equilibrium price rigidity can be sustained because rigid prices help firms overcome the time-inconsistency problem. If customers have incomplete information about firms' desired prices, the optimal policy for the firm is to commit to a "price cap". Our model therefore provides an explanation for the simultaneous existence of a rigid regular price and frequent sales, a pattern that is difficult to reconcile with existing menu cost models or price rigidity. Our model also explains survey evidence on firms' fears of adverse customer reactions to price changes, the fact that firms make open commitments to customers not to change their prices, the tendency of price rigidity to increase with the frequency of repeat purchases and the tendency of prices to be more rigid to existing customers than new customers.

Keywords: Time-inconsistency, Price Rigidity, Habit Formation, Asymmetric Information.

JEL Classification: E30

*We would like to thank Alberto Alesina, Susanto Basu, Daniel Benjamin, Michael Katz, David Laibson, Greg Mankiw, Alice Nakamura, Ariel Pakes, Ricardo Reis, Kenneth Rogoff, Julio Rotemberg, Michael Woodford and seminar participants at Harvard for valuable comments and discussions.

1 Introduction

A consumer's past purchases of a particular product often exert a strong positive influence on his current demand for this product. Such time non-separability of preferences arise for many different reasons. Some goods are addictive while consumers develop a sense of "brand-loyalty" to others. Consumers favor some products that they have used in the past because of compatibility with other equipment while they favor other products because the quality of competing products is unknown to them. And consumers continue using some products simply because of the large transaction costs associated with switching to a competitor (e.g., another bank or another internet service provider).

For all these reasons, it is common for consumers to be partially locked into purchasing a particular product once they have begun purchasing it. Similar lock-in effects are common when firms purchase from suppliers. Blinder et al. (1998) note that 85% of all goods and services in the U.S. non-farm business sector are sold to 'regular customers' and that 70% of these are business-to-business transactions. Shapiro and Varian (1999, ch. 5 and 6) present a detailed discussion of the importance of lock-in in business-to-business transactions.

In this paper, we study the implications that this has for firm price setting. Following Ravn et al. (2005), we formalize the time non-separability of consumer demand with a model of good-specific habits. We interpret this good-specific habit as providing a reduced form specification for the effects of the various types of switching costs described above as well as capturing the type of addiction studied by Becker and Murphy (1988). We solve for the consumer's demand curve given these preferences and assuming rational expectations. We show that consumer demand is forward-looking; consumer demand depends negatively not only of the current price of the product but also of the consumer's expectations about the good's future prices.

The forward-looking nature of consumer demand implies that firms face a time-inconsistency problem. Since consumers' current demand depends negatively on expected future prices of the product as well as its current price, firms would like to promise that they will keep their prices low in the future. However, when the future arrives and consumers are locked in, the firms have an incentive to renege on their earlier promises and price gouge. The consumers understand these incentives and don't take the firms' promises at face value unless the firms are able to make credible commitments. We show that if firms are not able to make credible commitments this time-inconsistency problem leads them to set prices that are sub-optimally high both from a profit perspective and from the perspective of overall welfare.

The model we analyze is a model of "customer markets". The seminal paper on customer markets is Phelps and Winter (1970).[1] An important drawback of the earlier literature on customer markets is that customers' demand curves are not derived from the behavior of forward-looking, optimizing agents. We show that the conclusions of the customer markets literature change substantially once the forward-looking nature of customers is taken into account. Most importantly, in the earlier literature, firms do not face a time-inconsistency problem.

Explaining price rigidity was a major motivation for the original development of customer markets models. According to Okun's (1981) "invisible handshake" version of the customer markets idea, firms have implicit agreements with their customers not to take advantage of tight market conditions by raising their price in exchange for stable prices in weak markets. This view of price rigidity finds strong support in the views of firm managers. When managers of U.S. manufacturing firms were asked why they don't change their prices more often than they do, by far the most frequent answer they gave was that they feared that this would "antagonize" their customers (Blinder et al., 1998). Similar surveys in a host of other countries have since confirmed that the most important reason cited by firm managers for price rigidity is that they are loathe to "damage customer relations" by changing their prices.[2]

The problem with this explanation for price rigidity has been that the customer markets literature has not provided a convincing rationale for why firms enter into these implicit contracts with their customers. Our model suggests that the reason may be that firms are trying to build and maintain a reputation for not taking advantage of locked-in customers. In other words, prices may be rigid because firms are trying to "commit to a sticky price". In section 4, we show that firms benefit from the ability to set rigid nominal prices since this partially alleviates their time-

[1] Other contributions include Okun (1981), Bils (1989), Rotemberg and Woodford (1991, 1995) and Bagwell (2004).

[2] See Apel et al. (2004) for a survey of Swedish firms; Hall et al. (1997) for U.K. firms; Amirault et al. (2004) for Canadian firms; and Fabiani et al. (2004) for a meta-study of surveys of firms in Belgium, Germany, Spain, France, Italy, Luxembough, the Netherlands, Austria and Portugal. A consistent finding across these surveys is that firms rate implicit and explicit contracts as the most important (or, in a few cases, among the most important) sources of price rigidity. In contrast, menu-costs and information costs typically rank rather low among the reasons for price rigidity. Fabiani et al. (2004) is particularly noteworthy due to its size (over 10,000 respondents) and scope (nine countries and many different sectors).

inconsistency problem. An equilibrium exists in our model in which firms commit to rigid nominal prices. In this equilibrium, firms are induced not to deviate from otherwise time-inconsistent actions by the threat that a deviation would damage their reputation and trigger an adverse shift in consumer expectations about future prices. In section 6, we present numerous quotes from firms' marketing rhetoric in which they promise customers not to increase prices, sometimes with the stated goal of not adversely affecting consumers' expectations about future prices.

The time-inconsistency problem that firms face implies that there is a fundamental difference between our model and the more standard "no-habit" model. In the no-habit model, there is only one equilibrium and that equilibrium does not entail nominal price rigidity. In our model, there are many equilibrium price paths associated with reputational equilibria, all of which are preferred to the discretionary equilibrium. Whether price rigidity arises thus becomes a question of equilibrium selection, as in Hall (2005). One might argue that reputational equilibria are hard to achieve since they require that customers understand the firm's pricing rule. However, a commitment to a constant price seems particularly simple for a firm to convey. Moreover, barriers to price adjustment, such as menu costs, can help firms commit to price rigidity. Analogous mechanisms that help firms make state-contingent commitments are less available.

In section 5, we consider an extension of our basic model in which variables that affect the firm's pricing problem—such as its marginal costs and the demand for its products—are unobservable or too costly for the firm's customers to observe. In the standard no-habit model, this is irrelevant since it is unnecessary for the consumer to understand the firm's optimization problem. However, in the habit model, asymmetric information limits the variables that it is possible, even in principle, for the firm to make commitments contingent on. We use the results of Athey et al. (2004) to show that the firm's optimal pricing policy under this kind of asymmetric information is to commit to a "price cap". Under this policy, the firm acts with discretion when its desired price is low, but when its desired price is high the firm sets its price equal to the price cap. The price cap has the beneficial effect that it lowers the customers' expectations about future prices and thereby increases demand. Given plausible assumptions about the process followed by the desired price and the extent of informational asymmetries, the firm's price will be "stuck" at the price cap a significant fraction of the time. It will, however, frequently drop below the price cap and exhibit much more flexibility when it is not at the price cap.

Our model therefore has the following empirical prediction: Goods prices should spend a significant portion of their time at a rigid upper bound. Below this upper bound, they should be much more flexible. As the reader is no doubt aware from casual observation, two of the most salient features of retail price series are the existence of a "regular" price, which remains unchanged for long periods of time, and frequent "sales"—i.e., brief periods during which the price drops below its regular price before returning back to the old regular price.[3] In section 6, we document these features of retail prices formally using the Dominick's Finer Foods dataset provided by the University of Chicago Graduate School of Business. We furthermore show that sales prices are about 8 times more flexible than regular prices.

To date, price rigidity and the existence of frequent sales have been studied separately. On the one hand, there is a large literature in macroeconomics about price rigidity. Theoretical work seeking to understand price rigidity has focused on the notion that there may be costs associated with changing prices.[4] Several features of retail price data are however difficult to reconcile with existing models of menu costs. These include the incredible number of sales observed in retail price data and the fact that prices frequently return to the old regular price after sales. However, the combination of a price cap rule and menu costs that only apply to changes in the "regular price" is consistent with the data. In a model without habit, a menu cost that does not apply to temporary price changes yields the counterfactual prediction that "reverse sales" should occur as frequently as sales.

On the other hand, there is a large literature in applied microeconomics and industrial organization documenting the existence of frequent sales and seeking to understand why they arise.[5] An important idea in this literature is that sales may be used to price discriminate. However, these models cannot account for the existence of a rigid regular price that truncates the price distribution from above. Our model is the only model of rational agents we are aware of that is consistent with both rigid regular prices and frequent sales.[6]

[3] See figures 1-3 for examples of this pattern.

[4] Empirical studies of price rigidity include Carlton (1986), Cecchetti (1986), Kashyap (1995), Blinder et al. (1998), Bils and Klenow (2004), Klenow and Kryvtsov (2005) and Konieczny and Skrzypacz (2005). Contributions to the literature on menu costs include Barro (1972), Akerlof and Yellen (1985), Mankiw (1985), Caplin and Spulber (1987) and Golosov and Lucas (2005).

[5] Contributions to the literature on sales include Salop (1977), Varian (1980), Salop and Stiglitz (1982), Conlisk et al. (1984), Lazear (1986), Pashigian and Bowen (1991), Warner and Barsky (1995), Aguirregabiria (1999), Hosken et al. (20000), Pesendorfer (2002), Chevalier et al. (2003) and Hendel and Nevo (2003).

[6] Rotemberg (2004) presents a model in which consumers become angry if they perceive firm pricing to be unfair.

In section 6, we discuss a number of existing empirical results that support our model of price rigidity. In particular, we discuss experimental evidence supporting the notion that prices are stickier in customer markets. We also discuss empirical work showing that prices to new customers are less rigid than prices to old customers.

We build heavily on recent work by Ravn et al. (2005). While the primary focus of their paper is a model of good specific external habits, they also derive consumer demand in the case of good specific internal habits. They note that in the internal habits model the firm faces a time inconsistency problem but leave for future research a detailed analysis of the firm's pricing problem in this case. Our paper focuses on analyzing this problem.

The paper proceeds as follows: In section 2, we derive the demand curve for consumers that form habits in individual goods. In section 3, we discuss the time-inconsistency problem faced by firms and solve for the optimal pricing rule in the polar cases of fully state-contingent commitment and complete discretion. In section 4, we show that firms benefit from price rigidity and that price rigidity is therefore an equilibrium outcome of our model. In section 5, we derive the optimal pricing policy of the firm when it has private information about its desired price. In section 6, we present empirical evidence supporting our model. Section 7 concludes.

2 Demand When Consumers Have Good Specific Internal Habits

Consider an economy in which there are a continuum of firms of measure one each of which produces a differentiated good. Consumers' preferences over the consumption of these goods are given by

$$E_0 \sum_{t=0}^{\infty} \beta^t U(C_t),$$

where

$$C_t = \left[\int_0^1 (c_t(z) - \gamma c_{t-1}(z))^{\frac{\theta_t - 1}{\theta_t}} dz \right]^{\frac{\theta_t}{\theta_t - 1}}, \tag{1}$$

$c_t(z)$ denotes the consumption of good z at time t and θ_t is the consumers' elasticity of demand at time t. This utility function implies that consumers' utility from the consumption of any particular good is not only a function of their current consumption of that good. It also depends on their past consumption of that good. In other words, the consumer has a habit in each of the differentiated

He shows how this model is consistent with both price rigidity and temporary sales.

goods. The parameter $\gamma \geq 0$ is a measure of the degree of this good-specific habit.[7] For simplicity we choose a specification of utility in which the consumer's elasticity of demand is only a function of time. The time variation in the consumer's elasticity of demand should be viewed as a stand-in for all the time varying features of demand that affect the firm's optimal price and that are not explicitly modeled.

Theoretical work on habit formation has largely focused on models in which consumers form habits in their total level of consumption rather than forming a habit in a particular good. Constantinides (1990) and Fuhrer (2000) consider a model in which consumers' utility from consumption depends on past values of their own consumption (internal habit). Abel (1990) and Campbell and Cochrane (1999) instead study models in which consumers are "catching up with the Joneses"—i.e., their utility from consumption depends on past values of aggregate consumption (external habit).

The consequences of consumers forming habits in individual goods has until recently not received much attention, to our knowledge. In a recent paper, Ravn et al. (2005) study the consequences of external habit in specific goods for the cyclicality of markups. Ravn et al. (2005) also derive consumer demand in the case of internal habit, but leave a detailed analysis of the firm's pricing problem in this case for future research. In contrast we focus on the case of good specific internal habit. The only other paper we are aware of that considers good-specific internal habit is Becker and Murphy's (1988) model of rational addiction. While our model is formally a model of addictive goods, we interpret it as also capturing in a reduced form way "switching costs" of the type discussed in Klemperer (1995).

The consumers face two types of decisions about consumption. They must decide how much to spend on consumption at each point in time and they must decide how to allocate their spending at each point between the different goods. These two problems may be analyzed separately. We focus on the allocation of spending across goods at a particular point in time. Given a state contingent path for total consumption $\{C_{t+j}\}_{j=0}^{\infty}$, the consumers seek to minimize their expenditures. Formally,

[7] By assuming that $\gamma \geq 0$, we are focusing on goods for which a consumer's past purchases exert a *positive* influence on current demand. While this is true for many goods, there also exist goods for which a consumer's purchases in the recent past *negatively* influence current demand. This is true, e.g., for durable goods. For such goods, equations (1) and (2) with $\gamma < 0$ may imply a reasonable reduced form model for consumer demand. To the extent that this is the case, the results of our model hold for this class of goods as well as the class of goods we focus on. See footnotes 17 and 19 for a more detailed discussion of what our model implies in the $\gamma < 0$ case.

the consumers choose $c_t(z)$ to minimize

$$E_t \sum_{j=0}^{\infty} M_{t,t+j} \int_0^1 p_{t+j}(z) c_{t+j}(z) dz$$

subject to $\{C_{t+j}\}_{j=0}^{\infty}$, where $M_{t,t+j}$ denotes the stochastic discount factor that the consumers use to value future cash flows.

The solution to this optimization problem implies that consumer demand for good z is

$$c_t(z) = \gamma c_{t-1}(z) + C_t \left(\frac{E_t \sum_{j=0}^{\infty} \gamma^j M_{t,t+j} p_{t+j}(z)}{P_t} \right)^{-\theta_t}, \tag{2}$$

where P_t denotes the price level.[8] Notice that when $\gamma = 0$ and θ_t is a constant, this demand curve reduces to the iso-elastic Dixit-Stiglitz demand curve. When $\gamma \neq 0$, demand differs from this simple benchmark in two ways. First, demand at time t depends on last period's demand. Second, current demand is influenced not only by the current price but also by the consumer's expectations about the future price of the good. The intuition for these two effects is straight-forward. When the consumer has a habit, his utility depends directly on his consumption in the last period. His demand today therefore depends on his consumption last period. However, the consumer also understands that by consuming a particular good today he is increasing his habit in the good, thereby increasing his future demand for it. As a consequence, the consumer's demand today is affected by how costly it will be to feed his habit in the future, i.e., his demand will depend on his expectations about the future price of the good.

3 Price Setting by Firms

For simplicity we adopt the setting of monopolistic competition. Since each firm faces a downward sloping demand curve—equation (2)—it is able to set the price of the good it produces. Firms are indexed by z. Firm z seeks to maximize its value,

$$E_0 \sum_{t=0}^{\infty} M_{0,t} [p_t(z) c_t(z) - W_t L_t(z)], \tag{3}$$

subject to the constraint that it produces at least as much as it sells,

$$c_t(z) \leq A_t f(L_t(z)), \tag{4}$$

[8] P_t is the index of individual prices that has the property that $P_t C_t$ is the minimum expenditure required to achieve a utility level C_t. P_t is also the Lagrange multiplier in the consumer's constrained expenditure minimization problem.

and subject to the demand for its product, given by equation (2). Here A_t denotes an exogenous technology factor, $L_t(z)$ denotes the firm's labor demand and W_t denotes the wage paid by the firm to its employees.

An important consequence of consumers having good-specific internal habits is that the firm faces a time-inconsistency problem when setting its price. Since consumer demand depends negatively on expected future prices of the product as well as its current price, the firm would like to be able to affect the consumer's expectations by promising a low price in the future. However, when the future arrives, the firm has an incentive to renege on its earlier promise by charging a high price. The consumers understand these incentives and don't take the firm's promises at face value unless the firm is able to make a credible commitment. In this section, we focus on the two polar cases: full commitment to a state-contingent rule and complete discretion. In sections 4 and 5 we explore some intermediate cases.

Solving analytically for optimal behavior under discretion is difficult since the constraints imposed on the firm's optimization problem by its inability to commit are complicated. We therefore resort to approximation methods of the sort that are widely used in monetary economics (see, e.g., Woodford, 2003; and Benigno and Woodford, 2004). We approximate the firm's problem around its steady state solution under full commitment to a state-contingent rule and assume that exogenous shocks and the habit coefficient, γ, are small. In addition, we make several simplifying assumptions about functional form: We assume that the firm's production function is linear; that $M_{t,t+j} = \beta^j$; that C_t and P_t are constant; and that W_t, A_t and θ_t are i.i.d. The details of our derivations are presented in appendix A.

When the firm is able to commit to a fully state contingent rule it chooses to set its price such that

$$\hat{p}_t(z) = \hat{S}_t + \epsilon_t, \tag{5}$$

where hatted variables denote percentage deviations from steady state of the corresponding unhatted variables, S_t denotes marginal costs and $\epsilon_t = -\hat{\theta}_t/(\theta - 1)$ denotes shocks to demand.[9] We define $\Phi_t \equiv \hat{S}_t + \epsilon_t$ and refer to Φ_t as the firm's desired price.

[9]For robustness, in appendix A we also drive the exact solution to the firm's problem under commitment without imposing the simplifying assumptions discussed above but instead assuming that θ_t is a constant. In this case, the price of the good also varies one for one in percentage terms with marginal costs.

Notice that the firm's desired pricing policy does not exhibit any real rigidity.[10] This contrasts with the results of earlier customer market models such as those in Phelps and Winter (1970) and Rotemberg and Woodford (1991, 1995) in which the consumer demand function is not derived from micro-foundations. In these papers, firms optimally vary their price less than one for one with marginal costs. Thus, markups vary countercyclically.

One of the ideas earlier customer markets models meant to capture in a reduced form way was that consumers face switching costs. In these models, firms can invest in a "customer base" by lowering their current price. New customers are then reluctant to switch to another firm since this entails that they incur a switching cost. Each firm's customer base is therefore a slow moving variable. When firms are hit by a shock to marginal costs they are reluctant to raise their price since a higher price would erode their customer base. As a consequence of this, firm prices exhibit real rigidity.[11]

The crucial difference between our model and earlier customer markets models is that in our model consumers realize that their demand in future periods depends on their actions in the current period. This entails that consumers decide to become customers of a particular firm not only based on the current price of the firm's product but also based on their expectations about its future prices. In contrast, the earlier customer market literature assumes that changes in a firm's market share are a function only of the firm's current price, which is not consistent with the interpretation that consumer's reluctance to switch is due to switching costs. Surely consumers realize that if they become customers of a particular firm they will become partially locked into that relationship in the future. Equation (5) shows that, given the consumption aggregator (1), it is optimal for a firm facing forward looking consumers to let its price vary one-for-one in percentage terms with marginal costs.

Next, consider the optimal pricing strategy of a firm that is not able to make time-inconsistent commitments. In appendix A, we show that, to a first order approximation, the "discretionary" pricing rule chosen by such a firm is

$$\hat{p}_t(z) = \frac{\gamma}{\theta - 1} + \hat{S}_t + \epsilon_t, \tag{6}$$

[10] We define real rigidity as a situation in which the pricing decisions of different firms are strategic complements.

[11] Ravn et al. (2005) show that a model in which consumers have good-specific external habit yields the consumer demand function assumed in the earlier customer markets literature.

where hatted variables again denote the percentage difference from the steady state under commitment. The positive constant term in this equation implies that producers of habit-forming goods set higher prices on average if they are not able to make time-inconsistent commitments. Their inability to make commitments leads them to exploit the habit of their customers to a greater extent than is optimal. The higher price implies a lower demand and lower profits for the firm. The higher price, of course, also hurts consumers. The firm's inability to make time-inconsistent commitments therefore leads to lower social welfare as well as lower profits for the firm.[12]

The idea that firms have an incentive to price gouge when consumers are locked into a relationship with the firm is not new. This idea has been explored in Cremer (1984), Farell and Shapiro (1989), Klemperer (1995), Bagwell (2004) and Caminal (2004). All these papers differ in significant ways from our paper. None of them explore how lock-in effects can lead to price rigidity as we do in section 4. Nor do they discuss optimal firm behavior when the firm's desired price is unobservable to its customers as we do in section 5.

4 Equilibrium Price Rigidity

Our results in section 3 imply that the ability to make price commitments is valuable to a firm since it alleviates the firm's time-inconsistency problem. This raises a familiar question: How does the firm make credible commitments? One approach is for the firm to build a reputation for offering low prices.[13] A key difference between our model and the standard "no-habit" model is that in our model there exist a multitude of equilibria in which the firm is induced not to deviate from otherwise time-inconsistent actions by the threat that a deviation would damage its reputation and trigger an adverse shift in consumers' expectations about its future prices.

One pricing rule that, in principle, may be sustained by a firm's reputation is the fully state-contingent commitment rule described in section 3. However, equilibria involving much simpler pricing rules also exist in our model. In particular, equilibria exist in which the firm sets rigid

[12]In discussing the commitment case, we emphasized that it is optimal for the firm to vary its price one-for-one in percentage terms with marginal costs. While equation (6) seems to indicate that the same is true in the discretion case, we would like to caution that, in contrast to the commitment case, this result holds only approximately in the discretion case. While the solution to the commitment case is exact, the solution to the discretion case and all the cases considered later in the paper rely on an approximation. In these cases, the fact that the firm's price varies one-for-one with marginal costs follows from the assumption that the habit coefficient is small.

[13]We discuss other commitment mechanisms below.

prices. To show formally that such equilibria exist, we must show that the the firm can attain higher profits if it is able to fix its price for multiple periods than it can attain under discretion.[14]

Consider a firm that is identical to the one analyzed in section 3 except that it is able to fix its price for two periods. Assume that the firm is otherwise not able to make any time-inconsistent commitments about its pricing policy. In appendix A we show that the optimal pricing policy of such a firm is

$$\hat{p}_t(z) = \frac{\gamma}{(\theta-1)(1+\beta)} + \frac{1}{1+\beta}(S_t + \epsilon_t). \tag{7}$$

This policy differs in two ways from the pricing behavior of a firm that follows the discretionary pricing policy. The benefit that comes from fixing the price for two periods is that the average level of the price is lower than under complete discretion. The average price is lower because the firm recognizes that a high price in period t raises consumer's expectations about the price in period $t+1$ and therefore raises the consumer's cost of forming a habit in the good. Since this lowering of the average price brings the average price closer to what it would be under commitment to a fully state-contingent rule, the firm's profits are higher in this case than they are under discretion.

The cost of fixing the price for more than one period is that the firm is not able to respond optimally to fluctuations in marginal costs and demand. Instead of responding one-for-one in percentage terms to such variations, the firm only changes its price by $1/(1+\beta)$ percent for each percentage deviation in marginal costs and demand. The simple intuition for this result is that the firm is choosing a price that is appropriate not only for the current period but for the entire period during which the price is fixed and it is discounting the future by a factor β. This feature of the firm's pricing policy lowers its profits relative to what they are under discretion.

Whether it is beneficial for the firm to be able to fix its price for more than one period therefore depends on the relative strength of these two effects. In appendix A we show that it is beneficial for the firm to be able to fix its price for two periods if

$$\gamma^2 > \frac{\beta(\theta-1)^2}{2+\beta}\mathrm{var}(\hat{S}_t + \epsilon_t). \tag{8}$$

This expression has a straight-forward interpretation. It says that being able to commit to a fixed price for two periods yields higher profits if the size of the habit coefficient—i.e., the strength of the habit—is large relative to the variability of marginal costs and demand.

[14] The existence of such equilibria also relies on the discount factor of the firm being close enough to one, as is standard in trigger-strategy equilibria.

We have analyzed the simple case of a firm that is able to fix its price for two periods. The results above can, however, easily be extended to the case of a firm that is able to fix its price for n periods. Another simplifying assumption employed above is that the aggregate price level is constant. This assumption is also easily relaxed. Commiting to a fixed nominal price is beneficial to the firm as long as variations in the price level are not too large.[15]

The fact that the fixed price policy is preferable to the discretionary policy from the firm's perspective means that price rigidity is an equilibrium outcome of our model. In this equilibrium the firm commits to a sticky price and the threat of consumer beliefs reverting to the discretionary equilibrium induces the firm to follow through on its commitment.

A fundamental difference between our model and the standard "no-habit" model thus arises with respect to the viability of equilibria involving nominal rigidity. Our model has a multiplicity of equilibria, some of which involve nominal rigidity. In contrast, the no-habit model has a unique equilibrium and this equilibrium does not entail nominal price rigidity. The equilibrium is unique because consumers' expectations about the firm's future prices don't affect current demand. Shifts in these expectations don't affect the firm's profits. Threats of such shifts therefore cannot be used to sustain a range of equilibria.

The presence of nominal price rigidity in the set of equilibrium outcomes of our model has an important parallel in the recent literature on wage stickiness. Hall (2005) shows that nominal wage stickiness can also arise as an equilibrium outcome in search models of the labor market. Hall's results follow from the fact that the outcome of the bargain between workers and firms, once they have been matched, is indeterminate in such models.

We have analyzed three equilibria of our model: commitment to a fully state contingent rule, complete discretion and an equilibrium in which the price is fixed for two periods. Clearly, many other equilibria exist. Wether price rigidity arises therefore becomes a question of equilibrium selection. The equilibrium most prefered by the firm is the fully state contingent commitment rule—equation (5). However, conveying such a complicated commitment to consumers may be difficult and poses a risk of misunderstandings that may lead to adverse shifts in consumer beliefs.

[15] Notice that given a similar condition to condition (8), consumers also prefer the two period fixed price policy—equation (7)—to the discretionary price policy—equation (6). The fact that the average price is lower makes consumers better off. The effect of lowering the variability of prices is however ambiguous. If the habit is large enough relative to the variability of price, the first effect will outway the second effect.

Furthermore, it may not be possible, even in principle, for a firm to commit to such a rule if the firm's marginal costs and demand are unobservable. A simpler, less risky pricing rule may therefore arise in the market such as sticky price rule described above or the price cap rule discussed in section 5.

Reputational equilibria of the kind discussed above provide a rational interpretation for the notion of "implicit contracts" discussed informally by Okun (1981) and found by Blinder et al. (1998) to be an important source of price rigidity. In Blinder et al. (1998), 64.5% of firms report that they have implicit contracts with their consumers and an overwhelming majority of these firms (79%) indicate that these implicit contracts are an important source of price rigidity. Surveys in many other countries have since confirmed this result (see footnote 2). Furthermore, the punishment phase of such reputation equilibria provides an interpretation for consumers' adverse reactions to price increases, not justified by observable increases in costs. Consumers often perceive such price increases as "unfair" (see, e.g., Kahneman et al., 1986; and Rotemberg, 2002 and 2004). In the reputational equilibria, it is exactly these types of price increases that lead to adverse reactions by customers.

Aside from repuation, there are a number of other mechanisms that a firm has at its disposal to make commitments. Menu costs and other barriers to price changes, can help a firm commit not to change its prices. Levy et al. (1997) present evidence that supermarkets face physical, managerial and communication-related costs of changing prices. Since it is optimal for firms to economize on such costs, it may be impractical for them to commit to a state-contingent rule. The menu cost will tilt the firm's incentives away from changing its price and therefore make it more likely that the firm's current price will not change in the near future. Just as in the simple case analyzed above, such price rigidity implies that a price increase in period t raises consumer's expectations about the price in the near future and therefore raises the consumer's cost of forming a habit in the good. Menu costs and other barriers to price changes can therefore be beneficial to a firm since they reduce the firm's incentive to take advantage of locked in customers.

One reason why one might be skeptical of menu costs as an explanation of price rigidity is that one might think that technologies exits that make changing prices easy and cheap (see, e.g., Dutta et al., 1999). However, the argument above suggests that firms might have an incentive to intentionally adopt technologies and an organizational structure that makes changing prices costly as part of a commitment not to take advantage of locked in customers. In most models of price rigidity, it is assumed that firms are forced to change their price infrequently. In such models price rigidity hurts the firms, although their losses are only second order (see Akerlof and Yellen, 1985; and Mankiw, 1985). Our model suggests that firms would actually like to be able to commit to change prices infrequently if state-contingent commitments are not possible.[16]

Another approach to making credible commitments is for the firm to sign binding contracts with its customers. Much like reputation formation, explicit contracts are an imperfect commitment mechanism. Contracts are costly to write, interpret and enforce. Furthermore, these costs rise with the length and complexity of the contract. Such costs can explain why empirical evidence suggests that fixed price contracts are quite common in one form or another in interactions between firms and their customers. Blinder et al. (1998) presents evidence to this effect. In their sample, 65% of firms had a meaningful volume of contracts that specified a fixed nominal price and 57% of these firms indicated that such nominal contracts were an important source of price rigidity. Explicit contracts have since been found to rank among the most important sources of price rigidity in many other countries (see footnote 2).[17]

5 Optimal Policy under Asymmetric Information

Many components of a typical firm's marginal costs and demand are either unobservable or very costly for a consumer to observe. In section 3, we show that in a complete information setting the firm's desired pricing policy under full commitment is a function of the firm's marginal costs and its demand. If marginal costs and demand are unobservable, it is not possible, even in principle, for a firm to commit to such a rule since there is no way for consumers to verify whether the firm deviates from this rule or not. This observation raises the question: What is the optimal pricing

[16] Nishimura (2000) also discusses possible benefits of price rigidity. His argument for the benefits of price rigidity is however quite different.

[17] All the results of this section and section 3 hold not only when $\gamma \geq 0$ but also for $\gamma < 0$. As we mentioned in footnote 7, the demand curve—equation (2)—with $\gamma < 0$ may be interpreted as describing consumer demand for goods for which consumer's purchases in the recent past negatively affect their current demand. Durable goods are examples of such goods. In this case the firm faces a slightly different time-inconsistency problem. It would like to be able to commit not to *lower* its price in the immediate future since expectations of low future prices will lead consumers to delay their purchases. This implies that firms again have an incentive to make repricing costly in order to make it more credible that they will not "take advantage of past customers" by lowering their price.

policy for the firm when it has private information about its desired price?[18]

It turns out that this question is formally related to the problem studied by Athey et al. (2004). They study the time-inconsistency problem of a central bank that has private information about the state of the economy. Using methods developed by Abreu et al. (1990), they are able to show that under relatively mild restrictions this type of problem has a surprisingly simple solution. In this section, we use the results of Athey et al. (2004) to show that the firm's optimal policy when it has private information about its desired price is to commit to a "price cap". More specifically, when the firm's desired price is relatively low it acts with discretion but when the desired price is high enough that discretionary price setting would entail a price above the price cap it sets its price equal to the price cap. Athey et al. (2004) refer to this as bounded discretion. The level of the price cap depends on the severity of the time-inconsistency problem, which in turn depends on the strength of the habit that consumers develop in the firm's good. The more severe is the time-inconsistency problem, the lower is the price cap.

Formally, we show in appendix B that:

I. If $\gamma > -\underline{\hat{\Phi}}$, the firm sets a constant price.

II. If $\gamma < -\underline{\hat{\Phi}}$, the firm's optimal policy is to commit to a price cap.

Here $\underline{\hat{\Phi}} < 0$ is the lowest possible realization of the firm's desired price. Let $\hat{p}^*(\hat{\Phi}; z)$ denote the static best response of a firm with desired price equal to $\hat{\Phi}$. If a firm's desired price is lower than $\hat{\Phi}^*$, the firm sets its price equal to $\hat{p}^*(\hat{\Phi}; z)$. However, whenever the firm's desired price is higher than $\hat{\Phi}^*$, the firm sets its price equal to the static best response of a firm with desired price equal to $\hat{\Phi}^*$, i.e., $\hat{p}^*(\hat{\Phi}^*; z)$. This pricing policy can be written more succinctly as

$$\hat{p}(z) = \begin{cases} \hat{p}^*(\hat{\Phi}; z) \text{ if } \hat{\Phi} \in [\underline{\hat{\Phi}}, \hat{\Phi}^*] \\ \hat{p}^*(\hat{\Phi}^*; z) \text{ if } \hat{\Phi} \in [\hat{\Phi}^*, \bar{\hat{\Phi}}]. \end{cases} \tag{9}$$

In appendix B, we show that the cutoff level of the firm's desired price, $\hat{\Phi}^*$, is decreasing in γ. Thus, the firm's desire to limit its discretion increases with the severity of the time-inconsistency problem.

[18] For simplicity, in this section we assume that the firm's private information is the only impediment it faces to making commitments about its pricing policy.

[19]

The results above show that the firm's optimal pricing policy when it has private information about its desired price is one in which its price is upward rigid at a price cap. Below this cap the firm's price is flexible. Even a casual look at time series of goods prices reveals that exactly these features—a rigid price cap and frequent and flexible sales—appear to be salient features of goods prices. In section 6, we provide formal empirical evidence that shows that these empirical predictions of our model are indeed prominent features of retail prices.

Notice also that we have shown that the price cap policy is the best policy from the firm's perspective of all policies that do not depend on the firm's contemporaneous desired price. This policy is therefore more desirable for the firm than the fixed price policy we discussed in section 4. This provides a rationale for why firms that are unable to make complicated commitments may choose a price cap policy even if their inability to commit is not strictly due to asymmetric information. Moreover, consumers also have an incentive to move from the discretionary equilibrium to the price cap policy since it lowers the average price of the good.

Here we have derived results for the simple case in which the consumer cannot observe any of the variables that the firm would like to make its price depend on. Our results can, however, be extended to a setting in which the consumer observes some such variables but not others. In this case, the variables that the consumer observes are state variables and thefirm-ptiomal pricing rule is a price cap that depends on these variables.

6 Empirical Evidence

In this section we present several different types of empirical evidence supporting our model of price rigidity. We first present two kinds of new evidence on price rigidity: evidence from retail price data on the behavior of regular prices and sale prices and evidence on company announcements about their future prices. We then discuss three sets of existing evidence supporting our model.

[19] As with the earlier sections, the results of this section may also be extended to the case of $\gamma < 0$. In this case the optimal pricing policy from the firm's perspective is a "price floor" rather than a price cap. This is because in the $\gamma < 0$ case the firm's time-inconsistency problem leads firms to set too low prices rather than too high prices (see footnote 17).

6.1 New Evidence from Retail Prices

In section 5, we show that our model has the following empirical prediction: Goods prices should spend a significant portion of their time at a rigid upper bound. Below this upper bound, they should exhibit much more flexibility. In tables 1 and 2, we use weekly price data from the Dominick's Finer Foods (DFF) dataset provided by the University of Chicago Graduate School of Business to show that these predictions are indeed borne out by data on retail goods prices.[20] More precisely, the results presented in tables 1 and 2 along with the fact that we very rarely observe "reverse-sales"—i.e., brief periods during which the price of a good rises above its regular price and then returns back to the regular price—show that: i) The regular price of a good remains fixed for long periods of time, but during this time the good frequently goes on sale for brief periods; ii) Regular prices are a sticky upper bound for the price of a good; iii) Prices generally return to their old regular price after sales; and iv) Sale prices are more than 8 times more flexible than regular prices. For robustness, the statistics in tables 1 and 2 are presented separately for each of 26 categories of goods. Hosken and Reiffen (2004) document similar qualitative results to (i) and (ii) for a panel of monthly data from 30 U.S. metropolitan areas.

The concept of a "regular price" is familiar in the literature on retail prices. Chevalier et al. (2003) comment,

> In general, pricing at DFF (and, we believe, at all supermarkets) is characterized by temporary discounting. Prices frequently drop to a temporary sale price and return again to the "normal" price. The path of prices for a typical good (9.5 ounce Triscuit crackers) in our study can be seen in Figure 1. Notice that, during the 7.5 years of our study, Triscuits appear to have only eight "regular prices". Upward deviations from the regular price are virtually nonexistant; temporary downward deviations are frequent.

The labeling of promotions in the Dominick's dataset is, however, somewhat undependable.[21] Moreover, what we typically view as a sale—i.e., a short-term decrease in prices relative to a recurrent

[20] DFF is the second-largest supermarket chain in the Chicago metropolitan area with approximately 100 stores and a 25% market share. DFF provided the University of Chicago Graduate School of Business (GSB) with weekly store-level scanner data, available at http://gsbwww.uchicago.edu/kilts/research/db/dominicks/. See Chevalier et al. (2003) for a more detailed description of this data set. We use data from store number 126 since the data from this store has the least missing data points.

[21] According the University of Chicago GSB website describing the data, "if the variable is set it indicates a promotion, if it is not set, there might still be a promotion that week".

upper bound—is more closely related to the time series behavior of prices than the presence of a promotion. We therefore identify sales directly from observations on prices as periods when the price drops for a short period and then returns to either a previously occurring regular price or to a new regular price that reoccurs soon after.[22] The "sales filter" used to identify sales is described in detail in appendix C. To give the reader a feel for this procedure, we present several figures showing the original and "regular price" series for popular items in appendix C. The figures show that the regular price series generated by this procedure corresponds well with our intuition about how to define a sale. The price series have infrequent adjustments in regular prices and frequent sales. When no recurring regular price can be identified from the data, the sales filter simply sets the regular price equal to the observed price. Thus, a continuously adjusting price series would have the regular price always equal to the actual price—i.e., no sales—with a regular price change in every period.

A very irregular pattern of sales, such as the one near the end of Figure 2, is not identified by the sales filter. The sales filter is, thus, somewhat conservative in assigning variation in prices to sales rather than the regular price. This tendency biases us away from finding a high frequency of sales, and a low frequency of price adjustment of regular prices—two of the key findings discussed in this section. Another comforting fact about our procedure is that the qualitative findings (i)- (iv) are not at all sensitive to the exact parameters used in the sales filter. Furthermore, Hosken and Reiffen (2004) document very similar qualitative results for (i) and (ii) using an entirely different data set and a different procedure for identifying sales.

The first column of Table 1 presents the fraction of weeks in which the price of the good was equal to the regular price. One minus this number is the fraction of time the good was on sale. By our measure, sales occur about 13% of the time. The first column of table 2 establishes furthermore that this regular price often remains fixed for significant periods of time—the frequency of price adjustment of regular prices is 6.1% or less in more than half of the categories.

The pricing dynamics observed in the data are hard to reconcile with the standard menu cost model of price rigidity. In this model, the firm should always readjust the regular price when a sale ends. Yet, after a large number of sales, the price returns to the original regular price. Column 2 of

[22]This procedure has the advantage over the procedure suggested in Hosken and Reiffen (2004)—of defining sales as percentage deviations from the modal price—that it can accomodate variation in the regular price witin a year and allows for sales that last more than one period.

table 1 shows that for most products the price of the product returns to the original regular price over 90 percent of the time following a sale.[23] Given the high frequency of sales in retail data, this statistic implies that the opportunity to adjust a price following a sale is often forgone. Indeed the condition that the price returns to the original price following a price decrease is sometimes use as a criterion for identifying a sale in other papers in the literature (see, e.g., Hosken and Reiffen, 2004Hosken and Reiffen (2004)).

The observed pricing dynamics are also difficult to reconcile with the existing literature on sales. An important explanation for sales in the industrial organization literature is price discrimination (see, e.g., Varian, 1980). The intuition for this theory of sales is that sales allow for price discrimination between shoppers with different price elasticities. However, these models do not provide an explanation for the existence of a rigid regular price that truncates the price distribution from above unless consumer valuations are also truncated from above.

The results in table 2 show that sale prices are considerably more variable than regular prices. The fourth column of table 2 reports the number of unique sale values as a fraction of the total number of weeks spent on sale. This statistic would equal 1 if there were a unique sale price in every period and would approach zero if only one sale price was ever visited. The median value of this fraction across categories is 43%. In contrast, the fraction of unique regular price values as a fraction of total time at regular prices is about 10 time smaller—4.5% or less for the majority of items.[24] The data are not, therefore, consistent with the idea that the price always returns to a particular sale price when the product goes on sale.

A slightly different way of analyzing the relative rigidity of sale prices is to look at the tendency of prices to adjust *while* the product is on sale versus at other times. Recall that our procedure for identifying sales allows for sales that last for more than one week. Multi-week sales account for somewhat less than half of sales in most categories. The first two columns of table 2 compare the frequency of price adjustment for regular prices versus sale prices during multi-week sales, not including the price changes at the start and end of the sale. The frequency of price adjustment during sales is about 8 times as high as the frequency of adjustment of the regular price. Existing

[23]This is not by construction. Our sales filter allows for sales that do not return to the original price following the sale, as we discuss in C.

[24]An even higher fraction of sale prices are unique if the prices are defined in terms of percent off the regular price, or an absolute amount off the regular price.

menu cost models of price rigidity do not provide any reason why the price of a good should be more flexible when it is on sale. As we showed in section 5, this pricing pattern is however a natural implication of our model. Again, these empirical facts do not arise from the particular approach used to identify sales, since our algorithm does not make any assumptions about the dynamics of prices during a sale.

From the perspective of the customer markets model presented in this paper, this pattern of pricing reflects the fact that the firm chooses to commit to a sticky regular price. Indeed, many retail stores choose to employ observably less permanent technologies for posting sale versus regular prices. This suggests that menu costs may be smaller for temporary price changes than for changes in the regular price. However, a model with such differential menu costs on its own is not fully consistent with the data since it implies that we should observe reverse sales as frequently as we observe sales. The model presented in section 5 shows that committing to a sticky regular price, but allowing sale prices to fluctuate, is preferable from the perspective of the firm to fixing its price for multiple periods or other types of pricing rules that do not depend on costs. Indeed, the results of Section 5 imply that this pricing rule is close to optimal in the class of all possible rules if the cost and demand factors affecting the optimal pricing of a supermarket are unobservable (or costly to observe) for consumers.

6.2 New Evidence from Company Announcements

If barriers to price adjustment are a hindrance to firms, why do firms self-impose restrictions to their future prices? On May 23 2002, Marvel CEO Bill Jemas began a pricing conference with the statement: "Read my lips, we will not raise prices." On Oct 9 2000, Revlon Inc. announced as part of its new terms of trade a "commitment not to raise prices for its retail partners in 2001". On Dec 1 2004, Apple Computer "flatly denied a report that...[it] was planning to raise prices for songs bought on the popular iTunes online music store...'These rumors aren't true,' said Apple spokeswoman Natalie Sequerira. 'We have multiyear agreements with the labels and our prices remain 99c a track.' " On Aug 24 2004, B. Muthuraman, managing director of Tata Steel said, "We will not increase prices for both our direct customers as well as our retail customers til March 2005." These examples were collected from news articles and company webpages on the internet. A number of similar examples from the steel industry, power and electricity, petroleum and gas, telephone services, internet service providers and other industrial and consumer goods industries are presented in table 3.

In some cases, an explanation is provided. The large fence manufacturer Sarel states:

> Sarel...has had no price increases for more than five years and no price changes are expected in the forseeable future.... When [the customers have] made their choice, the exceptional stability of our prices means that they know not only that they're getting superb value for their money today, but also that they will continue to do so in the future.

A small photofinishing company "Color Express" states:

> Once we publish our price list, our track record proves that we commit to those prices: it's not uncommon to maintain prices for one or two years barring significant increases in the paper industry. Take a look at other published prices, and you will find revisions sometimes as frequently as every 3-6 months. Even if the competitions prices are "slashed", doesn't it make you wonder?

Though far from conclusive, these anecdotes provide concrete examples of firms "committing to a sticky price", sometimes for the stated purpose of affecting consumers' future price expectations.[25]

6.3 Survey Evidence on the Reasons for Price Rigidity

An important source of evidence on price rigidity and the reasons for price rigidity is surveys. An influential survey on price rigidity was conducted by Blinder et al. (1998) for U.S. manufacturing firms. Blinder et al. interviewed managers at about 200 firms and asked them how often they changed their prices and why they didn't change them more often. This type of study has since been conduced in a host of other countries using similar methodology and in some cases with a much larger sample size than Blinder et al.'s original survey (see footnote 2).

The results of these surveys are strikingly similar across countries. A major conclusion of these studies is that the primary reason why firms seem to be reluctant to change their prices is because their customers don't like price variability rather than because such variability is costly for the firm independent of customer reactions. The importance of customer-based explanations for price

[25] Another potential explanation for firms pre-announcing their prices is collusion.

rigidity is reflected in robustly high scores for the 'implicit contracts' explanation for price rigidity and the robustly low scores for the menu cost and firm information cost explanations. Follow up questions in Blinder's survey also strongly suggest that the main concern that firms have with changing their prices is antagonizing customers.

6.4 Are Prices More Rigid in Customer Markets?

If consumer lock-in is an important source of price rigidity, we should observe stickier prices in firms that have more repeat customers. The existing survey and experimental evidence on the relationship between "customer markets" and price rigidity, though limited, suggests that this is indeed the case.

In an experiment on price-setting in customer markets, Cason and Friedman (2002) show that higher search costs lead customers to remain with sellers for longer periods. Sellers respond to this increase in loyalty with significantly more rigid prices. Renner and Tyran (2004) study a setting in which buyers are uncertain about the quality of competing products. They show that the price rigidity is more pronounced in a customer market than a market without repeat customers following an increase in costs, and that price rigidity is more pronounced if the increase in costs is unobservable than if it is public information. The latter finding lines up well with our results in Section 5.

Survey evidence also suggests that the link between customer markets and price rigidity may be important. In a survey of British firms, Hall et al. (1997) find that companies with over 75% of their customer relationships lasting for longer than five years rated fixed-price contracts as more important than firms with a smaller fraction of long-term customers. Small and Yates (1999) find that customer turnover seems to have a significant effect on the responsiveness of prices to changes in cost, but not to changes in demand. Carlton (1986) finds no evidence for a relationship between price rigidity and the importance of long-term contracts in a cross-industry study of the Stigler-Kindahl data set. However, the number of observations in Carlton's study is small and the result may be confounded by other differences across industries.

6.5 Are Prices More Rigid for Existing Customers?

Another empirical implication of the model presented in sections 2-5 (more precisely, a slight extension of that model) is that if it is possible to price discriminate between new and old customers, prices for new customers should not exhibit the same degree of rigidity as prices for existing customers. This is because the firm does not face a time inconsistency problem vis-a-vis its new customers since the new customers are not yet locked in by past purchases. The practive of maintaining fixed prices for existing customers when prices for new customers are changed is referred to as "grandfathering" old prices for existing customers. This practice has been studied in the economics literature are for housing rents and long distance phone services. Genesove (2003) shows that the rent on an apartment is about twice as likely to change when a new tenant moves in as when an old tenant signs a new lease. Epling (2002) shows that long distance telephone companies often maintain fixed prices for existing customers when they change prices for new customers.

The results of Carlton (1986) also suggest more rigidity to existing customers. Carlton uses the Stigler-Kindahl data set to show that prices for a particular buyer are rigid for long periods of time and contrasts this with the results of Stigler and Kindahl (1970). Stigler and Kindahl show that price indexes of average transaction prices are quite flexible. Together these two facts strongly suggest that prices for existing customers are more rigid than prices for new customers for the Stigler-Kindahl data.

7 Concluding Remarks

In this paper, we show that time non-separabilities in consumer demand imply that firms face a time-inconsistency problem when they are choosing prices. They would like to promise low prices in the future. But when the future arrives they have an incentive to take advantage of consumers' habits and price gouge. In this model, price rigidity arises as an equilibrium outcome. Moreover, firms may benefit from menu costs since they help firms commit not to price gouge. The firms' optimal policy is to commit to a state-contingent pricing policy. However, there are various reasons why this pricing rule may not be selected in the market. One reason is that the firms' marginal costs and demand may not be observable. Another reason is that it may be costly to write complicated contracts or commit to a complicated pricing rule.

If firms have private information about their desired prices, the optimal pricing policy is to commit to a price cap. Our model therefore implies that prices should spend a significant portion of their time at a rigid upper bound. Below this upper bound, they should be much more flexible. As we show in section 6, the behavior of retail prices bears a striking resemblance to this price cap policy. In contrast, the combination of a rigid regular price and frequent sales is difficult to explain within standard models of menu costs. Our model also provides an explanation for the tendency of firms to cite adverse customer reations as an important reason for price rigidity, the tendency of prices to be more rigid in customer markets, and the tendency of prices to existing consumers to be more rigid than prices to new consumers.

A Solutions to Firm Optimization

A.1 Exact Solution in the Case of Full Commitment

Under the assumption of full commitment with a constant elasticity of demand θ, the firm's problem can be solved analytically without any simplifying assumptions. The firm seeks to maximize equation (3) subject to equations (2) and (4). A Lagrangian for this constrained optimization problem is

$$\mathcal{L}_0 = E_0 \sum_{t=0}^{\infty} M_{0,t}[p_t(z)c_t(z) - W_t L_t(z) - S_t(c_t(z) - A_t f(L_t(z)))$$
$$-\Psi_t(-p_t(z) + P_t C_t^{\frac{1}{\theta}}(c_t(z) - \gamma c_{t-1}(z))^{-\frac{1}{\theta}} - \gamma M_{t,t+1}(P_{t+1} C_{t+1}^{\frac{1}{\theta}}(c_{t+1}(z) - \gamma c_t(z))^{-\frac{1}{\theta}})],$$

where S_t and Ψ_t denote Lagrange multipliers. The first order conditions of this problem are

$$\Psi_t = -c_t(z),$$

$$S_t = \frac{W_t}{A_t f'(L_t(z))},$$

$$\frac{1}{\theta}(\Psi_t - \gamma\Psi_{t-1}) P_t C_t^{\frac{1}{\theta}}(c_t(z) - \gamma c_{t-1}(z))^{-\frac{1+\theta}{\theta}} = -p_t(z) + S_t$$
$$+\frac{\gamma}{\theta} E_t[M_{t,t+1}(\Psi_{t+1} - \gamma\Psi_t) P_{t+1} C_{t+1}^{\frac{1}{\theta}}(c_{t+1}(z) - \gamma c_t(z))^{-\frac{1+\theta}{\theta}}],$$

and a transversality condition.[26] Manipulation of these equations and equation (2) yields

$$p_t(z) = \frac{\theta}{\theta - 1} S_t.$$

Notice that this equation implies that under full commitment the firm sets prices in exactly the same way as it would if consumers did not have good specific habits.

A.2 A Derivation of a 2nd Order Approximation to the Firm's Value

Given the simplifying assumption that the firm's production function is linear we can substitute it into the expression for the firm's value and get

$$E_0 \sum_{t=0}^{\infty} \beta^t [p_t(z)c_t(z) - \frac{W_t}{A_t} c_t(z)],$$

[26]Throughout the paper we focus on bounded solutions. The transversality condtions of the various dynamic optimization problems solved in the paper always hold for all bounded solutions. We therefore ignore transversality conditions elsewhere in the paper.

where we have also replace $M_{0,t}$ by β^t. The analysis in section A.1 implies that in the steady state with full commitment

$$p(z) = \frac{\theta}{\theta - 1}\frac{W}{A},$$

where variables without subscripts denote steady state values. Notice furthermore that equation (1) implies that $C = (1-\gamma)c(z)$ and equation (2) implies that $(1-\gamma\beta)P = p(z)$. A second order Taylor series approximation of the value of the firm around the steady state of the solution in section A.1 is given by

$$E_0 \sum_{t=0}^{\infty} \beta^t \Big[c(z)(p_t(z) - p(z)) + \frac{1}{\theta} p(z)(c_t(z) - c(z)) + (p_t(z) - p(z))(c_t(z) - c(z)) \\ - \frac{\theta - 1}{\theta}(W_t - W)(c_t(z) - c(z)) + \frac{\theta - 1}{\theta}(A_t - A)(c_t(z) - c(z)) \Big] + \text{ex. terms} + \mathcal{O}(||\xi||^3), \quad (10)$$

where "ex. terms" stands for terms that are exogenous to the firm's decision problem, ξ stands for a vector of the exogenous variables and $\mathcal{O}(||\xi||^3)$ denotes higher order terms.

The exposition of our results is simplified if we make a change of variables. Let $\hat{c}_t(z) = \log(c_t(z)/c(z))$ and define hatted versions of all other variables in the same way. Making use of the fact that

$$c_t(z) = c(z)\left(1 + \hat{c}_t(z) + \frac{1}{2}\hat{c}_t(z)\right) + \mathcal{O}(||\xi||^3),$$

we can rewrite equation (10) as

$$E_0 \sum_{t=0}^{\infty} p(z)c(z)\beta^t \left[\left(\hat{p}_t(z) + \frac{1}{2}\hat{p}_t^2(z)\right) + \frac{1}{\theta}\left(\hat{c}_t(z) + \frac{1}{2}\hat{c}_t^2(z)\right) + \hat{p}_t(z)\hat{c}_t(z) - \frac{\theta - 1}{\theta}\hat{S}_t\hat{c}_t(z) \right] \\ + \text{ex. terms} + \mathcal{O}(||\xi||^3), \quad (11)$$

where $\hat{S}_t = (\hat{W}_t - \hat{A}_t)$.

A.3 Firm Behavior in the Case of Full Commitment

Assuming that the habit parameter γ is small, a second order approximation of consumer demand is given by

$$\left(\hat{c}_t(z) + \frac{1}{2}\hat{c}_t^2(z)\right) - \gamma\hat{c}_{t-1}(z) - \frac{1+\theta}{2\theta(1-\gamma)}\hat{c}_t^2(z) - \hat{c}_t(z)\hat{\theta}_t = \\ -\theta(1 - \gamma - \gamma\beta)\hat{p}_t(z) - \frac{\theta}{2}\hat{p}_t^2(z) + \gamma\beta E_t\hat{c}_{t+1}(z) + \mathcal{O}(||\xi, \gamma||^3). \quad (12)$$

We can rearrange this equation so that it says that

$$\frac{1}{1-\gamma-\gamma\beta}\hat{c}_t(z) - \frac{\gamma}{1-\gamma-\gamma\beta}\hat{c}_{t-1}(z) - \frac{\gamma\beta}{1-\gamma-\gamma\beta}E_t\hat{c}_{t+1}(z) = -\theta\hat{p}_t(z) - \frac{1}{2}\frac{1}{1-\gamma-\gamma\beta}\hat{c}_t^2(z)$$
$$+\frac{1}{2}\frac{1+\theta}{\theta(1-\gamma)(1-\gamma-\gamma\beta)}\hat{c}_t^2(z) + \frac{1}{1-\gamma-\gamma\beta}\hat{c}_t(z)\hat{\theta}_t - \frac{1}{2}\frac{\theta}{1-\gamma-\gamma\beta}\hat{p}_t^2(z) + \mathcal{O}(||\xi,\gamma||^3).$$

Now notice that equation (11) may be written

$$E_0\sum_{t=0}^{\infty} p(z)c(z)\beta^t\left[\frac{1}{\theta}\left(\frac{1}{1-\gamma-\gamma\beta}\hat{c}_t(z) - \frac{\gamma}{1-\gamma-\gamma\beta}\hat{c}_{t-1}(z) - \frac{\gamma\beta}{1-\gamma-\gamma\beta}\hat{c}_{t+1}(z)\right)\right.$$
$$\left. + \left(\hat{p}_t(z) + \frac{1}{2}\hat{p}_t^2(z)\right) + \frac{1}{\theta}\frac{1}{2}\hat{c}_t^2(z) + \hat{p}_t(z)\hat{c}_t(z) - \frac{\theta-1}{\theta}\hat{S}_t\hat{c}_t(z)\right] + \text{ex. terms} + \mathcal{O}(||\xi,\gamma||^3).$$

Substituting consumer demand into this expression now yields

$$E_0\sum_{t=0}^{\infty} p(z)c(z)\beta^t\left[\frac{1}{\theta}\left(-\frac{1}{2}\frac{1}{1-\gamma-\gamma\beta}\left(\hat{c}_t^2(z) - \frac{1+\theta}{\theta(1-\gamma)}\hat{c}_t^2(z) - 2\hat{c}_t(z)\hat{\theta}_t + \theta\hat{p}_t^2(z)\right)\right) + \frac{1}{2}\hat{p}_t^2(z)\right.$$
$$\left. + \frac{1}{\theta}\frac{1}{2}\hat{c}_t^2(z) + \hat{p}_t(z)\hat{c}_t(z) - \frac{\theta-1}{\theta}\hat{S}_t\hat{c}_t(z)\right] + \text{ex. terms} + \mathcal{O}(||\xi,\gamma||^3). \qquad (13)$$

In the last two steps of this derivation we have assumed that the firm solves its problem from the "timeless perspective" (see Woodford, 2003, and Benigno and Woodford, 2004). In this problem, this assumption amounts to assuming that the firm is able to make its commitment at least one period before its policy takes effect so as to be able to affect consumer expectations about its policy in the first period. If we assumed that the firm did not optimize from the timeless perspective, the expression above would have an extra $\hat{c}_t(z)$ term in the first period which would imply that the firm would behave differently in the first period compared with all subseqent periods. The special aspects of the firm's behavior in the first period would reflect the fact that it was taking past expectations as given in the first period while it was seeking to affect future expectations by its commitment. We assume that the firm optimizes from the timeless perspective simply in order to be able to abstract from any special behavoir of the firm in the first period.

If we now multiply expression (13) by $(1-\gamma)(1-\gamma-\gamma\beta)$, use consumer demand to substitute for $\hat{c}_t(z)$ and simplify, we get that

$$E_0\sum_{t=0}^{\infty} p(z)c(z)\beta^t\left[\frac{1-\theta}{2}\hat{p}_t^2(z) - \hat{\theta}_t\hat{p}_t(z) + (\theta-1)\hat{S}_t\hat{p}_t(z)\right] + \text{ex. terms} + \mathcal{O}(||\xi,\gamma||^3).$$

Setting the derivative of this with respect to $\hat{p}_t(z)$ equal to zero shows that the firm's optimal pricing policy under full commitment to a state-contingent rule is

$$\hat{p}_t(z) = \hat{S}_t - \frac{1}{\theta-1}\hat{\theta}_t.$$

up to an error of order $\mathcal{O}(||\xi,\gamma||^2)$.

A.4 Firm Behavior in the Case of Complete Discretion

While consumer demand is again given by equation (12) in the case of full discretion, the firm must take the expectations of the consumers as given when it chooses how to set its price. We guess that equilibrium consumption may be represented by

$$\hat{c}_t = a_1 + a_2\hat{S}_t + \mathcal{O}(||\xi,\gamma||^2),$$

where a_1 and a_2 are undetermined coefficients. Since $\hat{S}_t$ is i.i.d., we have that

$$E_t\hat{c}_{t+1} = a_1 + \mathcal{O}(||\xi,\gamma||^2).$$

Notice that we need only use a first order approximation to the expectations of the agents since these expectations are multiplied by γ in equation (12) and we are assuming that γ is small. If we now plug this into the equation for consumer demand, equation (12), we get that

$$\begin{aligned}\left(\hat{c}_t(z) + \frac{1}{2}\hat{c}_t^2(z)\right) - \gamma\hat{c}_{t-1}(z) - \frac{1+\theta}{2\theta(1-\gamma)}\hat{c}_t^2(z) - \hat{c}_t(z)\hat{\theta}_t = \\ -\theta(1-\gamma-\gamma\beta)\hat{p}_t(z) - \frac{\theta}{2}\hat{p}_t^2(z) + \gamma\beta a_1 + \mathcal{O}(||\xi,\gamma||^3).\end{aligned}$$

Slight manipulation of this equation yields

$$\begin{aligned}-\theta\hat{p}_t(z) = {}& \frac{1}{1-\gamma-\gamma\beta}\hat{c}_t(z) - \frac{\gamma}{1-\gamma-\gamma\beta}\hat{c}_{t-1}(z) - \frac{\gamma\beta a_1}{1-\gamma-\gamma\beta} + \frac{1}{2}\frac{1}{1-\gamma-\gamma\beta}\hat{c}_t^2(z) \\ & -\frac{1}{2}\frac{1+\theta}{\theta(1-\gamma)(1-\gamma-\gamma\beta)}\hat{c}_t^2(z) - \frac{1}{1-\gamma-\gamma\beta}\hat{c}_t(z)\hat{\theta}_t + \frac{1}{2}\frac{\theta}{1-\gamma-\gamma\beta}\hat{p}_t^2(z) + \mathcal{O}(||\xi,\gamma||^3).\end{aligned}$$

Notice that equation (11) implies that

$$\begin{aligned}E_0\sum_{t=0}^{\infty} p(z)c(z)\beta^t \Big[\hat{p}_t(z) + \frac{1}{\theta}\left(\frac{1}{1-\gamma-\gamma\beta}\hat{c}_t(z) - \frac{\gamma}{1-\gamma-\gamma\beta}\hat{c}_{t-1}(z)\right) - \frac{\gamma}{\theta}\frac{1}{1-\gamma-\gamma\beta}\hat{c}_t(z) \\ +\frac{1}{2}\hat{p}_t^2(z) + \frac{1}{\theta}\frac{1}{2}\hat{c}_t^2(z) + \hat{p}_t(z)\hat{c}_t(z) - \frac{\theta-1}{\theta}\hat{S}_t\hat{c}_t(z)\Big] + \text{ex. terms} + \mathcal{O}(||\xi||^3)\end{aligned}$$

Using consumer demand to eliminate the first two terms in the above equation we get that

$$\begin{aligned}E_0\sum_{t=0}^{\infty} p(z)c(z)\beta^t \Big[-\frac{\gamma}{\theta}\frac{1}{1-\gamma-\gamma\beta}\hat{c}_t(z) - \frac{1}{2}\frac{1}{\theta}\frac{1}{1-\gamma-\gamma\beta}\hat{c}_t^2(z) + \frac{1}{2}\frac{1+\theta}{\theta^2(1-\gamma)(1-\gamma-\gamma\beta)}\hat{c}_t^2(z) \\ +\frac{1}{\theta}\frac{1}{1-\gamma-\gamma\beta}\hat{c}_t(z)\hat{\theta}_t - \frac{1}{2}\frac{1}{1-\gamma-\gamma\beta}\hat{p}_t^2(z) + \frac{1}{2}\hat{p}_t^2(z) + \frac{1}{2}\frac{1}{\theta}\hat{c}_t^2(z) + \hat{p}_t(z)\hat{c}_t(z) \\ -\frac{\theta-1}{\theta}\hat{S}_t\hat{c}_t(z)\Big] + \text{ex. terms} + \mathcal{O}(||\xi,\gamma||^3).\end{aligned}$$

Next we multiply the above equation by $(1-\gamma)(1-\gamma-\gamma\beta)$, use consumer demand to substitute for $\hat{c}_t(z)$ and simplify. This yields

$$E_0 \sum_{t=0}^{\infty} p(z)c(z)\beta^t \left[\gamma \hat{p}_t(z) - \frac{1}{2}(\theta-1)\hat{p}_t^2(z) - \hat{\theta}_t \hat{p}_t(z) + (\theta-1)\hat{S}_t \hat{p}_t(z)\right] + \text{ex. terms} + \mathcal{O}(||\xi,\gamma||^3).$$

Here we use the fact that a_1 is of order $\mathcal{O}(||\xi,\gamma||)$. Setting the derivative of this with respect to $\hat{p}_t(z)$ equal to zero yields

$$\hat{p}_t(z) = \frac{\gamma}{\theta-1} + \hat{S}_t - \frac{1}{\theta-1}\hat{\theta}_t, \tag{14}$$

up to an error of order $\mathcal{O}(||\xi,\gamma||^2)$.

A.5 Firm Behavior when Prices are Fixed for Two Periods

Let's next consider a case in which the firm is able to keep its price fixed for two periods. In a period t in which the firm is able to change its price, both the firm and consumers know that the price in period $t+1$ will be the same as the price at time t, i.e., they know that $\hat{p}_{t+1}(z) = \hat{p}_t(z)$. This implies that $\hat{c}_{t+1}(z) = \hat{c}_t(z) + \mathcal{O}(||\xi,\gamma||^2)$. The price set by the firm at time t therefore affects the consumer's expectations about outcomes in period $t+1$. The firm, however, takes the consumer's expectations about outcomes at $t+1+j$ for $j \geq 1$ as given. We guess that $E_t\hat{c}_{t+1+j}(z) = a_1 + \mathcal{O}(||\xi,\gamma||^2)$ is appropriate. All this implies that the demand curve of the consumers imposes the following constraints on the firm at time t:

$$\left(\hat{c}_t(z) + \frac{1}{2}\hat{c}_t^2(z)\right) - \frac{1+\theta}{2\theta(1-\gamma)}\hat{c}_t^2(z) - \hat{c}_t(z)\hat{\theta}_t = -\theta(1-\gamma-\gamma\beta)\hat{p}_t(z) - \frac{\theta}{2}\hat{p}_t^2(z) + \gamma\beta\hat{c}_t(z)$$
$$+\text{s.o.ex.terms} + \mathcal{O}(||\xi,\gamma||^3),$$

$$\left(\hat{c}_{t+1}(z) + \frac{1}{2}\hat{c}_t^2(z)\right) - \gamma\hat{c}_t(z) - \frac{1+\theta}{2\theta(1-\gamma)}\hat{c}_t^2(z) - \hat{c}_t(z)\hat{\theta}_{t+1} = -\theta(1-\gamma-\gamma\beta)\hat{p}_t(z) - \frac{\theta}{2}\hat{p}_t^2(z)$$
$$+\text{s.o.ex.terms} + \mathcal{O}(||\xi,\gamma||^3),$$

$$E_t\hat{c}_{t+2}(z) - \gamma\hat{c}_{t+1}(z) = -\theta E_t\hat{p}_{t+2}(z) + \text{s.o.ex.terms} + \mathcal{O}(||\xi,\gamma||^3),$$

$$E_t\hat{c}_{t+j}(z) = -\theta E_t\hat{p}_{t+j}(z) + \text{s.o.ex.terms} + \mathcal{O}(||\xi,\gamma||^3),$$

for $j \geq 2$, where s.o.ex.terms stands for "second order exogenous terms".

A second order approximation of the value of the firm is again given by expression (11). In this case expression (11) can be written

$$
\begin{aligned}
&p(z)c(z)\left(\hat{p}_t(z)+\frac{1}{\theta}\frac{1-\gamma\beta}{1-\gamma-\gamma\beta}\hat{c}_t(z)-\frac{1}{\theta}\frac{\gamma}{1-\gamma-\gamma\beta}\hat{c}_t(z)+\frac{1}{2}\hat{p}_t^2(z)+\frac{1}{2}\frac{1}{\theta}\hat{c}_t^2(z)+\hat{p}_t(z)\hat{c}_t(z)\right.\\
&\quad\left.-\frac{\theta-1}{\theta}\hat{S}_t\hat{c}_t(z)\right)+p(z)c(z)\beta\left(\hat{p}_t(z)+\frac{1}{\theta}\frac{1-\gamma}{1-\gamma-\gamma\beta}\hat{c}_{t+1}(z)+\frac{1}{2}\hat{p}_t^2(z)+\frac{1}{2}\frac{1}{\theta}\hat{c}_t^2(z)+\hat{p}_t(z)\hat{c}_t(z)\right)\\
&\quad+p(z)c(z)\beta^2\left(E_t\hat{p}_{t+2}(z)+\frac{1}{\theta}E_t\hat{c}_{t+2}(z)-\frac{\gamma}{\theta}\hat{c}_t(z)\right)+p(z)c(z)\beta^j\left(E_t\hat{p}_{t+j}(z)+\frac{1}{\theta}E_t\hat{c}_{t+j}(z)\right)\\
&\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad+\text{ex.terms}+\mathcal{O}(||\xi,\gamma||^3),
\end{aligned}
$$

for $j>2$. Next we plug the constraints implied by the demand curve into this expression. After we multiply the result by $(1-\gamma)(1-\gamma-\gamma\beta)$, this yields

$$
\begin{aligned}
&p(z)c(z)\left(-\frac{\gamma}{\theta}\hat{c}_t(z)+\frac{1+\theta}{2\theta^2}\hat{c}_t^2(z)+\frac{1}{\theta}\hat{c}_t(z)\hat{\theta}_t+\hat{p}_t(z)\hat{c}_t(z)-\frac{\theta-1}{\theta}\hat{S}_t\hat{c}_t(z)\right)\\
&\quad+p(z)c(z)\beta\left(\frac{1+\theta}{2\theta^2}\hat{c}_t^2(z)+\hat{p}_t(z)\hat{c}_t(z)\right)+\text{ex.terms}+\mathcal{O}(||\xi,\gamma||^3).
\end{aligned}
$$

If we now use the demand curve to eliminate $\hat{c}_t(z)$ we get

$$
\begin{aligned}
&p(z)c(z)\left(\gamma\hat{p}_t(z)-\frac{1}{2}(1+\beta)(\theta-1)\hat{p}_t^2(z)-\hat{\theta}_t\hat{p}_t(z)+(\theta-1)\hat{S}_t\hat{p}_t(z)\right)\\
&\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad+\text{ex.terms}+\mathcal{O}(||\xi,\gamma||^3).
\end{aligned}
$$

Setting the derivative of this with respect to $\hat{p}_t(z)$ equal to zero yields

$$
\hat{p}_t(z)=\frac{\gamma}{(\theta-1)(1+\beta)}+\frac{1}{1+\beta}\hat{S}_t-\frac{1}{1+\beta}\frac{1}{\theta-1}\hat{\theta}_t+\mathcal{O}(||\xi,\gamma||^2). \tag{15}
$$

A.6 Comparison of Profits

Next we would like to compare the profits of a firm that is not able to make any time-inconsistent commitments and a firm that is able to fix its price for two periods. The expectation of the stream of profits of a firm is

$$
E_0\sum_{t=0}^{\infty}p(z)c(z)\beta^t\left[\frac{1-\theta}{2}\hat{p}_t^2(z)-\hat{\theta}_t\hat{p}_t(z)+(\theta-1)\hat{S}_t\hat{p}_t(z)\right]+\text{ex. terms}+\mathcal{O}(||\xi,\gamma||^3).
$$

Using equation (14) we can derive that, ignoring exogenous terms and terms of higher than second order, the expected profit of a firm that optimizes under discretion is

$$
E_0\Pi^D=\frac{p(z)c(z)}{1-\beta}\frac{\theta-1}{2}\left[-\left(\frac{\gamma}{\theta-1}\right)^2+\text{var}(\hat{S}_t)+\frac{1}{(\theta-1)^2}\text{var}(\hat{\theta}_t)\right].
$$

Similarly, using equation (15) we can derive that the expected profit of a firm that is able to fix its price for two periods is

$$E_0\Pi^F = \frac{p(z)c(z)}{1-\beta}\frac{\theta-1}{2}\left[-\left(\frac{\gamma}{(\theta-1)(1+\beta)}\right)^2 + \frac{1+2\beta}{(1+\beta)^2}(\text{var}(\hat{S}_t) + \frac{1}{(\theta-1)^2}\text{var}(\hat{\theta}_t))\right].$$

Comparing these expressions we get that $E_0\Pi^F > E_0\Pi^D$ if

$$\gamma^2 > \frac{\beta(\theta-1)^2}{2+\beta}(\text{var}(\hat{S}_t) + \frac{1}{(\theta-1)^2}\text{var}(\hat{\theta}_t)).$$

B Results when Firms have Private Information

We begin by deriving the function in our model that correponds to $R(x_t, \mu_t, \theta_t)$ in Athey et al. (2004). Notice that a second order approximation of the value of the firm may be written

$$E_0\sum_{t=0}^{\infty} p(z)c(z)\beta^t \Big[\hat{p}_t(z) + \frac{1}{\theta}\left(\frac{1}{1-\gamma-\gamma\beta}\hat{c}_t(z) - \frac{\gamma}{1-\gamma-\gamma\beta}\hat{c}_{t-1}(z)\right) - \frac{\gamma}{\theta}\frac{1}{1-\gamma-\gamma\beta}\hat{c}_t(z)$$
$$+\frac{1}{2}\hat{p}_t^2(z) + \frac{1}{\theta}\frac{1}{2}\hat{c}_t^2(z) + \hat{p}_t(z)\hat{c}_t(z) - \frac{\theta-1}{\theta}\hat{S}_t\hat{c}_t(z)\Big] + \text{ex. terms} + \mathcal{O}(||\xi||^3)$$

and consumer demand may be written

$$-\theta\hat{p}_t(z) = \frac{1}{1-\gamma-\gamma\beta}\hat{c}_t(z) - \frac{\gamma}{1-\gamma-\gamma\beta}\hat{c}_{t-1}(z) - \frac{\gamma\beta}{1-\gamma-\gamma\beta}E_t\hat{c}_{t+1}(z) + \frac{1}{2}\frac{1}{1-\gamma-\gamma\beta}\hat{c}_t^2(z)$$
$$-\frac{1}{2}\frac{1+\theta}{\theta(1-\gamma)(1-\gamma-\gamma\beta)}\hat{c}_t^2(z) - \frac{1}{(1-\gamma-\gamma\beta)}\hat{c}_t(z)\hat{\theta}_t + \frac{1}{2}\frac{\theta}{1-\gamma-\gamma\beta}\hat{p}_t^2(z) + \mathcal{O}(||\xi,\gamma||^3).$$

Using consumer demand to eliminate the first two terms in the expression for the value of the firm given above we get

$$E_0\sum_{t=0}^{\infty} p(z)c(z)\beta^t \Big[-\frac{\gamma}{\theta}\frac{1}{1-\gamma-\gamma\beta}\hat{c}_t(z) + \frac{1}{\theta}\frac{\gamma\beta}{1-\gamma-\gamma\beta}E_t\hat{c}_{t+1}(z) - \frac{1}{2}\frac{1}{\theta}\frac{1}{1-\gamma-\gamma\beta}\hat{c}_t^2(z)$$
$$+\frac{1}{2}\frac{1+\theta}{\theta^2(1-\gamma)(1-\gamma-\gamma\beta)}\hat{c}_t^2(z) + \frac{1}{\theta(1-\gamma-\gamma\beta)}\hat{c}_t(z)\hat{\theta}_t - \frac{1}{2}\frac{1}{1-\gamma-\gamma\beta}\hat{p}_t^2(z) + \frac{1}{2}\hat{p}_t^2(z)$$
$$+\frac{1}{2}\frac{1}{\theta}\hat{c}_t^2(z) + \frac{1}{2}\frac{1}{\theta}\hat{c}_t^2(z) + \hat{p}_t(z)\hat{c}_t(z) - \frac{\theta-1}{\theta}\hat{S}_t\hat{c}_t(z)\Big] + \text{ex. terms} + \mathcal{O}(||\xi,\gamma||^3).$$

Next we multiply through by $(1-\gamma-\gamma\beta)(1-\gamma)$, use the demand curve to eliminate $\hat{c}_t(z)$ and focus only on terms that are affected by the firm's action at time t. This yields

$$R(E_{t-1}\hat{p}_t(z), \hat{p}_t(z), \hat{S}_t) = p(z)c(z)\left[\gamma\hat{p}_t(z) - \gamma E_{t-1}\hat{p}_t(z) - \frac{1}{2}(\theta-1)\hat{p}_t^2(z) - \hat{\theta}_t\hat{p}_t(z) + (\theta-1)\hat{S}_t\hat{p}_t(z)\right]$$
$$+\text{ex. terms} + \mathcal{O}(||\xi,\gamma||^3). \quad (16)$$

This is the function in our model that corresponds to $R(x_t, \mu_t, \theta_t)$ in Athey et al. (2004). Mapping our notation into the notation used by Athey et al. (2004) we get that: $x_t = E_{t-1}\hat{p}_t(z)$, $\mu_t = \hat{p}_t(z)$ and $\theta_t = \hat{S}_t - \hat{\theta}_t/(1-\theta) \equiv \Phi_t$. In the notation used by Athey et al. (2004), the firm's objective function is

$$R(x_t, \mu_t, \theta_t) = \gamma\mu_t - \gamma x_t - \frac{1}{2}(\theta - 1)\mu_t^2 + (\theta - 1)\theta_t\mu_t.$$

Notice that this function satisfies all the conditions required for the propositions in Athey et al. (2004) to be valid. Specifically, $R_x(x_t, \mu_t, \theta_t) = -\gamma < 0$, $R_{\mu\theta}(x_t, \mu_t, \theta_t) = \theta - 1 > 0$ and $R_{\mu\mu}(x_t, \mu_t, \theta_t) = -(\theta - 1) < 0$.

The main difference between our results and the results in Athey et al. (2004) is that they consider a model in which $R(x_t, \mu_t, \theta_t)$ is the social welfare function, i.e. it is the objective of all the agents in the model. The fact that $R(x_t, \mu_t, \theta_t)$ in Athey et al. (2004) is the social welfare function entails that the resulting policy is socially optimal. Here we use the objective of the firm as our $R(x_t, \mu_t, \theta_t)$, which means that the resulting policy is not socially optimal but rather the best policy from the perspective of the firm. The proofs in Athey et al. (2004) do not rely on $R(x_t, \mu_t, \theta_t)$ being a social welfare function. Only their interpretation as solving for the socially optimal policy relies on this.

Given equation (16) and the following monotone hazard conditions: $(1-P(\hat{\Phi}_t))/p(\hat{\Phi}_t)$ is strictly decreasing in $\hat{\Phi}_t$ and $P(\hat{\Phi}_t)/p(\hat{\Phi}_t)$ is strictly increasing in $\hat{\Phi}_t$, Proposition 1 in Athey et al. (2004) shows that the pricing policy that is optimal from the perspective of the firm is static. Here $p(\hat{\Phi}_t)$ and $P(\hat{\Phi}_t)$ denote the pdf and cdf of $\hat{\Phi}_t$, respectively. We assume that $\hat{\Phi}_t \in [\underline{\hat{\Phi}}, \bar{\hat{\Phi}}]$.

Furthermore, Proposition 2 in Athey et al. (2004) shows that the firm's best pricing policy is either a constant price or it is a policy of bounded discretion, i.e.,

$$\hat{p}(z) = \begin{cases} \hat{p}^*(\hat{\Phi}; z) \text{ if } \hat{\Phi} \in [\underline{\hat{\Phi}}, \hat{\Phi}^*] \\ \hat{p}^*(\hat{\Phi}^*; z) \text{ if } \hat{\Phi} \in [\hat{\Phi}^*, \bar{\hat{\Phi}}] \end{cases} \tag{17}$$

where $\hat{p}^*(\hat{\Phi}; z)$ denotes the static best response of a firm with a desired price equal to $\hat{\Phi}$ and $\underline{\hat{\Phi}} \leq \hat{\Phi}^* \leq \bar{\hat{\Phi}}$.

To complete the description of the policy most prefered by the firm, we must calculate four things: 1) Under what conditions does the firm prefer a constant price? 2) What is the optimal constant price from the firm's perspective? 3-4) When the firm prefers to set its price according to equation (17), what is the optimal cutoff point $\hat{\Phi}^*$ and what is the firm's static best response $\hat{p}^*(\hat{\Phi}; z)$?

The remainder of this section draws heavily on appendix D in Athey et al. (2004). First, notice that the static best reponse of the firm solves $R_{\hat{p}(z)}(E\hat{p}(z), \hat{p}(z), \hat{\Phi}) = 0$. The solution is

$$\hat{p}^*(\hat{\Phi}, z) = \frac{\gamma}{\theta - 1} + \hat{\Phi}. \tag{18}$$

If the firm's pricing policy is of the form (17), then

$$E\hat{p}(z) = \int_{\underline{\hat{\Phi}}}^{\hat{\Phi}^*} \hat{p}^*(\hat{\Phi}, z)p(\hat{\Phi})d\hat{\Phi} + \int_{\hat{\Phi}^*}^{\bar{\hat{\Phi}}} \hat{p}^*(\hat{\Phi}^*, z)p(\hat{\Phi})d\hat{\Phi}.$$

Using equation (18) to plug in for $\hat{p}^*(\hat{\Phi}, z)$ in this equation we get that

$$E\hat{p}(z) = \frac{\gamma}{\theta - 1} - \int_{\hat{\Phi}^*}^{\bar{\hat{\Phi}}} (\hat{\Phi} - \hat{\Phi}^*)p(\hat{\Phi})d\hat{\Phi}.$$

Athey et al. (2004) show that the objective of the firm, $\int R(E\hat{p}(z), \hat{p}(z), \hat{\Phi})p(\hat{\Phi})d\hat{\Phi}$ may be written

$$\begin{aligned} R(E\hat{p}(z), \hat{p}^*(\underline{\hat{\Phi}}, z), \underline{\hat{\Phi}}) &+ \int_{\underline{\hat{\Phi}}}^{\hat{\Phi}^*} R_{\hat{\Phi}}(E\hat{p}(z), \hat{p}^*(\hat{\Phi}, z), \hat{\Phi})[1 - P(\hat{\Phi})]d\hat{\Phi} \\ &+ \int_{\hat{\Phi}^*}^{\bar{\hat{\Phi}}} R_{\hat{\Phi}}(E\hat{p}(z), \hat{p}^*(\hat{\Phi}^*, z), \hat{\Phi})[1 - P(\hat{\Phi})]d\hat{\Phi}. \end{aligned}$$

Since $R_{\hat{\Phi}}(E\hat{p}(z), \hat{p}(z), \hat{\Phi}) = (\theta - 1)\hat{p}(z)$, this expression simplifies to

$$\gamma \int_{\hat{\Phi}^*}^{\bar{\hat{\Phi}}} (\hat{\Phi} - \hat{\Phi}^*)p(\hat{\Phi})d\hat{\Phi} + (\theta - 1) \int_{\underline{\hat{\Phi}}}^{\hat{\Phi}^*} \hat{\Phi}[1 - P(\hat{\Phi})]d\hat{\Phi} + (\theta - 1) \int_{\hat{\Phi}^*}^{\bar{\hat{\Phi}}} \hat{\Phi}^*[1 - P(\hat{\Phi})]d\hat{\Phi} + \text{ex. terms}.$$

Differentiating this with respect to $\hat{\Phi}^*$ and setting the resulting expression equal to zero yields

$$-\gamma \int_{\hat{\Phi}^*}^{\bar{\hat{\Phi}}} p(\hat{\Phi})d\hat{\Phi} + (\theta - 1) \int_{\hat{\Phi}^*}^{\bar{\hat{\Phi}}} [1 - P(\hat{\Phi})]d\hat{\Phi} = 0,$$

which is equivalent to

$$-\gamma[1 - P(\hat{\Phi}^*)] + (\theta - 1) \int_{\hat{\Phi}^*}^{\bar{\hat{\Phi}}} [1 - P(\hat{\Phi})]d\hat{\Phi} = 0.$$

When $\hat{\Phi}^* < \bar{\hat{\Phi}}$, $1 - P(\hat{\Phi}^*) > 0$, so this last equation is equivalent to

$$-\gamma + (\theta - 1) \int_{\hat{\Phi}^*}^{\bar{\hat{\Phi}}} \frac{1 - P(\hat{\Phi})}{p(\hat{\Phi})} \frac{p(\hat{\Phi})}{1 - P(\hat{\Phi}^*)} d\hat{\Phi} = 0. \tag{19}$$

Notice that the second term on the left hand side of this equaiton is the conditional mean of $(1 - P(\hat{\Phi}))/p(\hat{\Phi})$ over the interval $[\hat{\Phi}^*, \bar{\hat{\Phi}}]$. Since $(1 - P(\hat{\Phi}))/p(\hat{\Phi})$ is strictly decreasing in $\hat{\Phi}^*$

(monotone hazard assumption), its conditional mean is also strictly decreasing in $\hat{\Phi}^*$. This implies that equation (19) has at most one interior solution. Since the expression on the left hand side of equation (19) is decreasing in both γ and $\hat{\Phi}^*$, it is furthermore the case that $\hat{\Phi}^*$ is decreasing in γ.

We have shown that equation (19) has at most one interior solutions. To show that such a solution in fact exists we must show that the left hand side of this equation is negative for $\hat{\Phi}^*$ close $\bar{\hat{\Phi}}$ and positive for $\hat{\Phi}^* = \underline{\hat{\Phi}}$. Notice that when $\hat{\Phi}^* \to \bar{\hat{\Phi}}$, $(1 - P(\hat{\Phi}))/p(\hat{\Phi}) \to 0$. This implies that for $\gamma > 0$ and $\hat{\Phi}^*$ close enough to $\bar{\hat{\Phi}}$, the left hand side of equation (19) is strictly less than zero. When $\hat{\Phi}^* = \bar{\hat{\Phi}}$, equation (19) is not defined. However, $\hat{\Phi}^* = \bar{\hat{\Phi}}$ is a solution to the equation above equation (19). However, since the expression on the left hand side of that equation is strictly negative for $\hat{\Phi}^* < \bar{\hat{\Phi}}$ in the neighborhood of $\bar{\hat{\Phi}}$, this is not a local maximum.

Athey et al. (2004) show that at $\hat{\Phi}^* = \underline{\hat{\Phi}}$ the left hand side of equation (19) becomes $-\gamma - \underline{\hat{\Phi}}$. Since $\underline{\hat{\Phi}} < 0$, this is positive for $\gamma \in (0, -\underline{\hat{\Phi}})$. So, there is an interior solution in this case. When $\gamma > -\underline{\hat{\Phi}}$ there is no interior solution to equation (19). This implies that for this range of γ the firm's best policy is a constant price.

Finally, when $\gamma > -\underline{\hat{\Phi}}$ the firm chooses its constant price to maximize

$$\int_{\underline{\hat{\Phi}}}^{\bar{\hat{\Phi}}} R(E\hat{p}(z), \hat{p}(z), \hat{\Phi}) p(\hat{\Phi}) d\hat{\Phi}$$

subject to $E\hat{p}(z) = \hat{p}(z)$. The solution to this problem is $\hat{p}(z) = 0$.

C The Sales Filter

Let p_t denote the observed price at time t and r_t denote the "regular" price at time t. The sales filter has 6 steps for each time period which should be considered in order (i.e. step 1 has precedence over step 2, etc.). However, for the first time period, the algorithm implementing the filter should start at step 3 (the first step not to refer to r_{t-1}). The steps of the filter are:

0. If $p_t = r_{t-1}$, then $r_t = r_{t-1}$.
1. If $p_t > r_{t-1}$, then $r_t = p_t$.
2. If $r_{t-1} \in \{p_{t+1}, ..., p_{t+J}\}$, then $r_t = r_{t-1}$.
3. If the set $\{p_t, p_{t+1}, ..., p_{t+L}\}$ has K or more different elements, then $r_t = p_t$.

4. Define $p_{max} = \max\{p_t, p_{t+1}, ..., p_{t+L}\}$ and $t_{max} = \text{time}\max\{p_t, p_{t+1}, ..., p_{t+L}\}$. If $p_{max} \in \{p_{t_{max}}, p_{t_{max}+1}, ..., p_{t_{max}+L}\}$, then $r_t = p_{max}$.

5. $r_t = p_t$.

The filter has three parameters to be chosen by its user: J and K. We chose these parameters to be $J = 8$, $K = 3$, $L = 3$.

The filter identifies sales as brief period of time when the price of the good drops below its regular price before returning to its old regular price or a new reoccuring regular price. A simpler filter would only identify sales as cases when the price returns to the original regular price. However, our filter counts brief discounts followed by changes in the regular price as sales.

The parameters J, K and L determine how conservative the filter is at assigning price variation to sales rather than variation in the regular price. If, e.g., $J = K = L = 3$ any price change lasting longer than 3 periods is counted as a change in the regular price and any time 3 or more prices are seen in four consecutive periods the filter assigns variation in the price to variation in the regular price, not sales. This means that if two different sales with different sales prices happen with one or two periods in between all the variation in price is assigned to the regular price. If J, K and L are assigned higher values, longer and more irregular sales within a short period are allowed.

The parameters we use imply that the maximum duration of sales is 3 periods if the price returns to the original "regular price" following a sale (i.e., a v-shaped sale) and 7 periods if the price returns to a new recurring regular price following the sale.

Perhaps the best way to convince the reader that our sales filter correctly identifies sales is to show what happens when we apply the filter to a few price series. Figures 1-3 provide three examples. In each figure we plot the price of a good and the regular price shifted up by $1. Two things stand out: 1) Most of the time, the filter works very well. It filters out all sales and only sales. 2) The filter is somewhat conservative in assigning price variation to sales rather than the regular price. In particular, very irregular patterns of sales are attributed to variation in the regular price rather than variation in the sale price. The most striking example of this is the price of Diet Coke in the period form last 1995 to mid 1996. During this period, the price of Diet Coke varied rather eratically and the sales filter was unable to identify a stable regular price. This type of error tends to increase the frequency of price changes and the number of unique values in the regular price series. Both of these effects work against the results we present in section 6.

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Table 1: Descriptive Statistics on Retail Price Adjustment

Product	Fraction of Weeks at the Regular Price	Fraction of Sales that Return to the Regular Price
Analgesics	0.954 (0.001)	0.926 (0.008)
Bath Soap	0.921 (0.003)	0.938 (0.014)
Bathroom Tissues	0.825 (0.004)	0.937 (0.007)
Beer	0.758 (0.003)	0.925 (0.005)
Bottled Juices	0.831 (0.002)	0.956 (0.003)
Canned Soup	0.892 (0.001)	0.957 (0.003)
Canned Tuna	0.882 (0.002)	0.947 (0.006)
Cereals	0.931 (0.001)	0.947 (0.005)
Cheese	0.812 (0.002)	0.945 (0.003)
Cigarettes	0.995 (0.001)	0.897 (0.040)
Cookies	0.868 (0.001)	0.958 (0.003)
Crackers	0.837 (0.002)	0.968 (0.004)
Dish Detergent	0.886 (0.002)	0.969 (0.004)
Fabric Softeners	0.904 (0.002)	0.947 (0.006)
Front-end-candies	0.896 (0.002)	0.968 (0.004)
Frozen Dinners	0.768 (0.004)	0.963 (0.004)
Frozen Entrees	0.845 (0.001)	0.961 (0.002)

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Product	Fraction of Weeks at the Regular Price	Fraction of Sales that Return to the Regular Price
Frozen Juices	0.813 (0.002)	0.966 (0.004)
Grooming Products	0.889 (0.001)	0.929 (0.004)
Laundry Detergents	0.908 (0.002)	0.951 (0.005)
Oatmeal	0.907 (0.003)	0.970 (0.007)
Paper Towels	0.836 (0.004)	0.946 (0.007)
Refrigirated Juices	0.766 (0.003)	0.934 (0.005)
Shampoos	0.900 (0.002)	0.935 (0.004)
Snack Crackers	0.827 (0.002)	0.947 (0.004)
Soaps	0.871 (0.003)	0.952 (0.006)
Soft Drinks	0.750 (0.001)	0.957 (0.001)
Toothbrushes	0.871 (0.002)	0.935 (0.006)
Toothpastes	0.887 (0.002)	0.936 (0.005)
Median	0.871	0.947

Note: Standard Errors are in parentheses. The total number of observations is 985,022. The regular price and sale prices of a good are identified using the sales filter that is discribed in appendix C. Estimates are based on pooled data from each category.

Table 2: Adjustment of Regular versus Sale Prices

	Frequency of Price Change		Number of Unique Prices as a Fraction of Total Weeks	
Product	Regular Prices	Sale Prices	Regular Prices	Sales Prices
Analgesics	0.036 (0.001)	0.411 (0.013)	0.035 (0.001)	0.578 (0.019)
Bath Soap	0.026 (0.002)	0.354 (0.025)	0.031 (0.002)	0.531 (0.047)
Bathroom Tissues	0.110 (0.003)	0.491 (0.014)	0.064 (0.004)	0.359 (0.029)
Beer	0.063 (0.001)	0.200 (0.006)	0.040 (0.002)	0.195 (0.016)
Bottled Juices	0.084 (0.001)	0.454 (0.006)	0.053 (0.002)	0.404 (0.014)
Canned Soup	0.058 (0.001)	0.418 (0.007)	0.042 (0.001)	0.464 (0.016)
Canned Tuna	0.069 (0.002)	0.304 (0.008)	0.046 (0.003)	0.331 (0.013)
Cereals	0.069 (0.001)	0.528 (0.010)	0.061 (0.001)	0.668 (0.014)
Cheeses	0.111 (0.001)	0.530 (0.005)	0.080 (0.007)	0.395 (0.010)
Cigarettes	0.036 (0.001)	—	0.053 (0.001)	0.580 (0.037)
Cookies	0.046 (0.001)	0.500 (0.005)	0.034 (0.001)	0.426 (0.009)
Crackers	0.065 (0.001)	0.445 (0.008)	0.044 (0.002)	0.349 (0.013)
Dish Detergent	0.054 (0.001)	0.453 (0.011)	0.047 (0.002)	0.434 (0.018)
Fabric Softeners	0.057 (0.001)	0.404 (0.011)	0.045 (0.003)	0.495 (0.023)
Front-end-Candies	0.028 (0.001)	0.344 (0.008)	0.024 (0.001)	0.338 (0.016)
Frozen Dinners	0.066 (0.002)	0.551 (0.011)	0.040 (0.003)	0.432 (0.022)
Frozen Entrees	0.054 (0.001)	0.495 (0.006)	0.039 (0.001)	0.446 (0.007)

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Product	Frequency of Price Change: Regular Prices	Frequency of Price Change: Sale Prices	Number of Unique Prices as a Fraction of Total Weeks: Regular Prices	Number of Unique Prices as a Fraction of Total Weeks: Sales Prices
Frozen Juices	0.081 (0.002)	0.522 (0.009)	0.051 (0.002)	0.344 (0.011)
Grooming Products	0.034 (0.001)	0.497 (0.007)	0.036 (0.001)	0.442 (0.011)
Laundry Detergents	0.061 (0.001)	0.425 (0.009)	0.049 (0.003)	0.538 (0.027)
Oatmeal	0.071 (0.002)	0.530 (0.019)	0.062 (0.004)	0.607 (0.029)
Paper Towels	0.086 (0.003)	0.482 (0.015)	0.045 (0.004)	0.301 (0.023)
Refrigerated Juices	0.133 (0.002)	0.635 (0.008)	0.089 (0.005)	0.447 (0.016)
Shampoos	0.043 (0.001)	0.443 (0.010)	0.038 (0.001)	0.443 (0.013)
Snack Crackers	0.073 (0.001)	0.529 (0.007)	0.051 (0.002)	0.428 (0.013)
Soaps	0.051 (0.002)	0.510 (0.011)	0.039 (0.003)	0.449 (0.026)
Soft Drinks	0.076 (0.001)	0.652 (0.004)	0.042 (0.001)	0.309 (0.006)
Toothbrushes	0.049 (0.001)	0.406 (0.011)	0.045 (0.002)	0.403 (0.016)
Toothpastes	0.056 (0.001)	0.492 (0.009)	0.048 (0.001)	0.443 (0.013)
Median	0.061	0.487	0.045	0.434

Note: Standard Errors are in parentheses. The total number of observations is 985,022. The regular price and sale prices of a good are identified using the sales filter that is described in appendix C. The frequency of price change is calculated by dividing the total number of price changes by the total number of weeks. The statistics in columns three and four are calculated by first dividing the number of unique regular or sale prices observed for a product by the total number of weeks at the regular price or on sale and then averaging within categories.

Table 3: Evidence of Price Commitments

Company	Industry	Company Description	Date	Quote
Industrial				
Auto Suppliers				
Steel				
Indian Steel Alliance	steel	organization represents 5 leading steelmakers	5-Mar-04	Steelmakers in India will not increase prices of hot rolled steel coils until end of June even if input costs rise during this period, the chairman of an industry body (Indian Steel Alliance) said on Thursday
Tata Steel	steel	India	24-Aug-04	B Muthuraman, managing director, Tata Steel, said: “We will not increase prices for both our direct customers as well as retail customers till March 2005.” Tata Steel announcement assumed significance against the backdrop of rising global steel prices and large international steel companies like Arcelor and Posco already annoucing price hikes for the next quarter.
Other				
Siemens	equipment		31-Dec-69	Siemens make a commitment not to increase the price for the service indefinitely
Pioneer Hi-Bred International	agricultural products		29-Sep-98	announced it will not raise prices of its corn and soybean seed products in calendar year 1999, due to the "challenging economic conditions faced by US and Canadian farmers"
Sarel, brand of Schneider Electric	fences		1-Jun-01	Accompanying the catalogue is a new price list, the most important feature of which is what hasn't changed - the prices! In fact, Sarel, a brand of Schneider Electric, has had no price increases for more than five years, and no price changes are expected in the foreseeable future. "Our new catalogue and stable prices both, in their own way, demonstrate our commitment to enclosure users," said Brian O'Donoghue, marketing manager. "We have made a substantial investment in ensuring that our catalogue guides customers toward the most appropriate and most economical enclosure choices. When they've made their choice, the exceptional stability of our prices means that they know not only that they're getting superb value for money today, but also that they will continue to do so in the future."

Computer Related

Web Hosting			
Tech trade Internet Services	web hosting	29-Jan-05	Price Freeze Guarantee. Same price. Forever.
Infinity Hosting	web hosting	29-Jan-05	Price Promise: the price you paid when you opened your account iw the price you will always pay. No price increases no extra charges ever….No contract…cancel your hosting account…at any time
hostup.com	web hosting	29-Jan-05	we will never, ever increase the pricing of hosting plans…you will always pay the same fee for your hosting account
A1-hosting	web hosting	1-Dec-04	Life Time Price Guarantee…there will be no Price increases for the life of the time that you host with us
Cloch	web hosting	1-Dec-04	Price Promise: Cloch Internet will not raise the price of your hosting plan, even if the price increases for new customers
BurningBulb.net	web hosting	3-Dec-04	Price Freeze Guarantee. Our clients take comfort in knowing that regardless of our future pricing policies, their monthly fee will always remain the same. As our policies change for future accounts, current accounts continue to host at the same monthly fee charged at the time their account was setup.
Other			
DSLExtreme	internet services	3-Dec-04	Price Freeze Guarantee…Choose one of our exclusive Price Freeze Guarantee subscriptions. Clients who select this option will enjoy one low price for as long as they choose to keep the service. Your Price will never go up!
Optimum Online	cable internet	Nov-04	Cablevision Systems Corp. has announced that it will freeze prices for its Optimum Online high-speed Internet service in 2005. The announcement comes when the number of customers for that service has increased despite stepped-up competition, including discount prices, from phone companies including Verizon Communications.
Comodo	internet security	30-Oct-04	"We want to assure all our customers that our prices remain frozen,"; states Paul Tourret, Managing Director of Comodo Limited,"We launched Instant SSL several months ago as the market leader in low-cost, fully validated, fully supported high quality SSL Certificates. The recent price increases from Thawte and GeoTrust only strengthen our unique position in this market - through Instant SSL we ensure that high quality SSL webserver security will remain affordable.";

Power and Electricity

Electric Utilities

Powerco	utility		4-Jan-02	Powerco, New Zealand's third largest electricity and gas utility has implemented a 12 month voluntary price freeze from 1 April 2002 for its electricity lines charges for all its residential consumers in the central and lower North Island.
npower	utility		29-Jan-05	With npower you'll see no increase in your electricity and gas prices throughout the whole of 2005, providing there are no increases imposed by any governmental, statutory or licensing authority.
Bangor Hydro-Electric Company	utility	State of Maine utility	10-Jul-96	commitment not to raise prices

Oil and Gas

Bord Gais	utility	Bord Gáis Éireann (Bord Gáis) is a statutory body that was established under the 1976 Gas Act. The company is responsible for the transmission, distribution and supply of natural gas in Ireland. Bord Gáis, which is wholly owned by the Irish Government, employs over 800 staff and is headquartered at Gasworks Road, Cork.	29-Jun-00	Despite substantial increases in the supply cost of natural gas during the year, prices to consumers were not increased, in line with the company's commitment to maintain prices at existing levels until at least 2003. Natural gas prices for residential customers have not been increased since the mid-1980s.
Chinese Petroleum Corp	gas and oil	Taiwan	1-Apr-04	"will not raise prices before May 20"
Petron Corporation	diesel		? 2003	promised not to increase its prices any further for the rest of the year
Gazprom	gas and oil	Russia's oil and gas giant	3-Nov-99	Gazprom, Russia's oil and gas giant, does not intend to raise natural gas prices for its Russian clients this year, chairman of the company's board of directors Rem Vyakhirev said.

Other

ABB	utility supplier	ABB is a leader in power and automation technologies that enable utility and industry customers to improve performance while lowering environmental impact. The ABB Group of companies operates in around 100 countries and employs around 105,000 people.	25-May-04	In order to further strengthen our ties with our OEM customers, ABB will not be increasing prices on OEM medium voltage products. We will maintain the current price levels through the end of 2004, barring any further drastic changes in material costs
Pharmaceuticals				
GlaxosmithKline	pharmaceutical		Jul-02	will not raise wholesale prices of HIV drugs until January 2004. This will help low-income people who are uninsured or underinsured and rely on state programs and federal funding for their medications
Pfizer	pharmaceutical		Mar-02	2 year freeze on anti-retrovirals
Publishing				
Inspec	bibliographic services	Inspec is the leading English-language bibliographic information service providing access to the world's scientific and technical literature in physics, electrical engineering, electronics, communications, control engineering, computers and computing, information technology, production, manfacturing and mechanical engineering.	2001	INSPEC is pleased to announce a price freeze for 2002. This means no price increase for standalone customers and some networking customers will see a slight decrease.
Serials Solutions	library services	Serials Solutions Inc. provides complete e-journal access services to over 1000 libraries worldwide	19-Aug-03	Seattle, WA – August 19, 2003. Serials Solutions, Inc. announced today that it is freezing its 2003 price schedule and offering additional price breaks to keep services accessible for all libraries.

Consumer Goods

DHA Lighting	lighting	24-Jun-05	DHA Lighting has frozen prices on all products this year. The leading manufacturer of gobos, moving lighting effects, projection slides and creator of the Digital Light Curtain is holding its 2002 prices into 2003.
Marvel	comic books	23-May-02	Marvel CEO Bill Jemas began today's press conference by swiping a line from Bush the Elder and declaring, "Read my lips, we will not raise prices." The hastily called conference call with the comic press was arranged to provide a quick Marvel response to price increases on 20 books announced by DC Comics earlier in the week. Though Jemas did note that many companies traditionally took advantage of price hikes by the competition to raise prices on their own goods, he promised "that unless something drastic happens to the contrary, we will hold price indefinitely."
Jaguar	auto	15/10/1998	Speaking today at the Sydney International Motor Show 1998 industry day, Mr Danny Rezek, managing director of Jaguar Australia, said that:"Since its inception in 1922, Jaguar Cars has espoused a philosophy of offering customers excellent value for money. Jaguar Australia's commitment to this philosophy is evident in our announcement today of a price freeze on all Jaguar models for the next six months. This price freeze is testimony to our serious commitment to ensure our customers continue to receive best-in-class value," said Mr Rezek.
Mitsubishi South Africa	auto	23-Jun-05	Mitsubishi recently announced that it will not increase its prices for the remainder of 2001 and will only look at increasing prices in 2002.
Revlon	consumer goods	9-Oct-00	Revlon Inc. (NYSE: REV) today announced an innovative change to the way it does business with its U.S. retail partners to drive market growth and emphasize mutual success. In addition to the trade terms, the Company also announced a commitment not to raise prices for its retail partners in 2001.
Needham Junction ice cream	retail	5-May-04	In an article investigating the likelihood of future ice cream price increases: Around the middle of April…Turransky hiked the price of a small soft-serve ice cream cone...Turransky…stressed that he works with a printed menu, that he's already printed this season's and he won't be raising prices again
Apple Computer Inc	ipod music	1-Dec-04	Apple Computer Inc. on Friday flatly denied a report that the computer maker was planning to raise prices for songs bought on its popular iTunes online music store... "These rumors aren't true," said Apple spokeswoman Natalie Sequeira. "We have multiyear agreements with the labels and our prices remain 99c a track."

Consumer Services

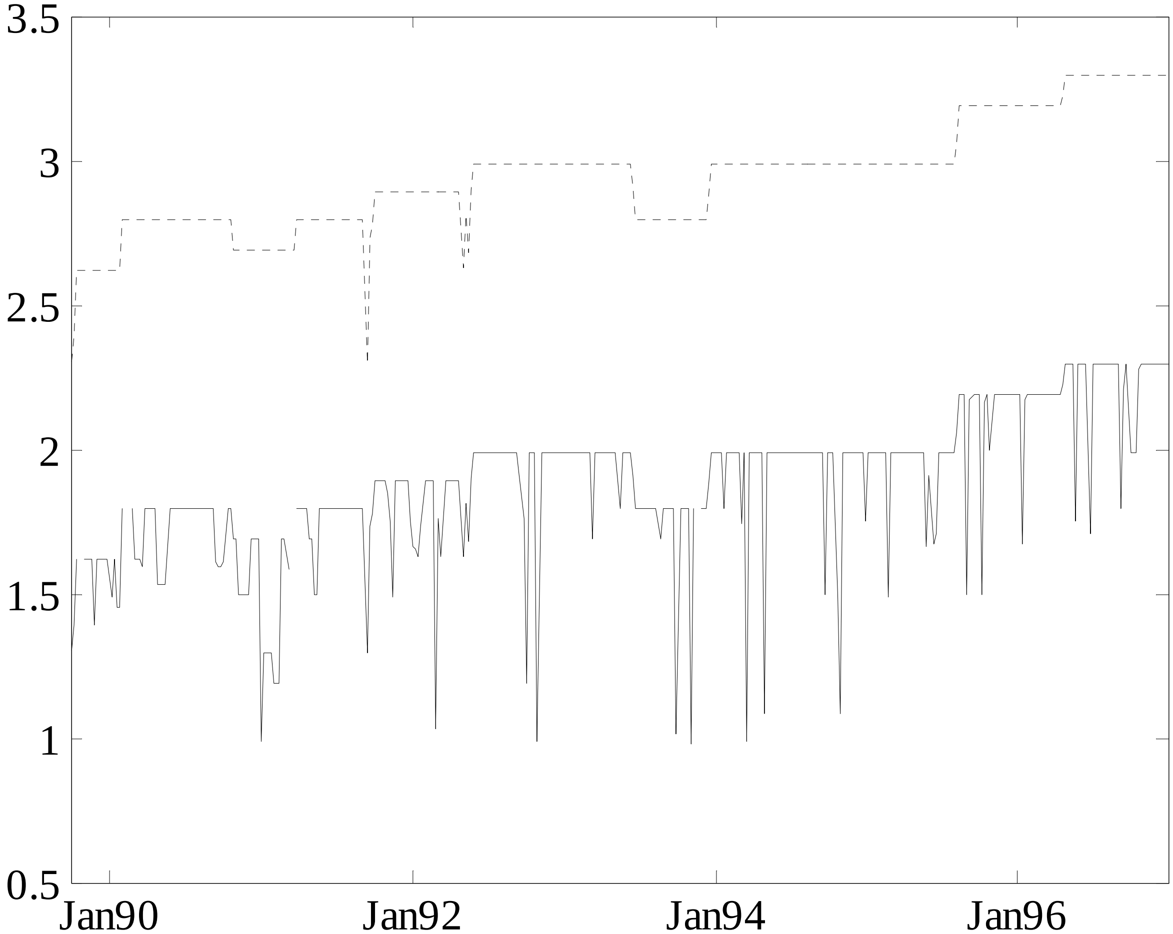
Telephone				
Illonois Bell Telephone Company	telephone		6/26/2004	Price protection which guarantees no price increases for the duration of the 12, 24, or 36 month plan
Bell	telephone		6/10/2004	SBC and other Bells have pledged not to increase wholesale prices until 2005
Citzens Communications co	telephone		6/23/1905	proposed agreement to purchase lines in rural Colorado: proposal included guarantee to "maintain current prices for at least a year"
Cell Phone				
Cantel Amigo	cell phone	Canada cell phone	11/13/1997	price guarantee: We promise no price increases and the flexibility to change plans if you need to, no long term contract
Healthcare				
Palmetto Health	healthcare	integrated healthcare delivery system	6/18/1996	Following merger, "guarantees that the new system will have no price increases for five years"
BUPA Ireland	healthcare	BUPA Ireland is part of BUPA, a global health and care organisation with members in over 190 countries. BUPA have been committed to Irish healthcare for more than 15 years.BUPA Ireland is a not-for-profit organisation.	7/9/2002	will not be increasing prices to customers this year
Other (Small)				
Color Express	film		1/1/2005	Our published price list is one of our commitments. We provide consistent, "no surprises" pricing for our customers. Once we publish our price list, our track record proves that we commit to those prices; it's not uncommon to maintain prices for one to two years barring significant increases in the paper industry. Take a look at other published prices, and you will find revisions sometimes as frequently as every 3 - 6 months. Even if the competition's prices are "slashed", doesn't it make you wonder?
Bravo Software	software		Sep-02	This feature is called "Price Lock". Price Lock will allow you to purchase additional add-ons for the same price as when you joined the program. No price increases ever, for as long as you are a Customer Care member.

Satin Ivy Laundry Service	laundry		Jan-05		We offer a personalised service at affordable prices. Once accepted, our prices are set for 12 months – in fact we rarely increase prices even then, unless the purchase price of linen is increased.
Robins School of Motoring	driving instruction		1/1/2005		On the FAQ page: Q. How often do you increase your prices? A. I try to keep my rates as competitive as possible and rarely increase prices, this will depend mainly on the increase in the price of fuel and the general economy, over the last two years I have only increased my prices once by £1

University Procurement

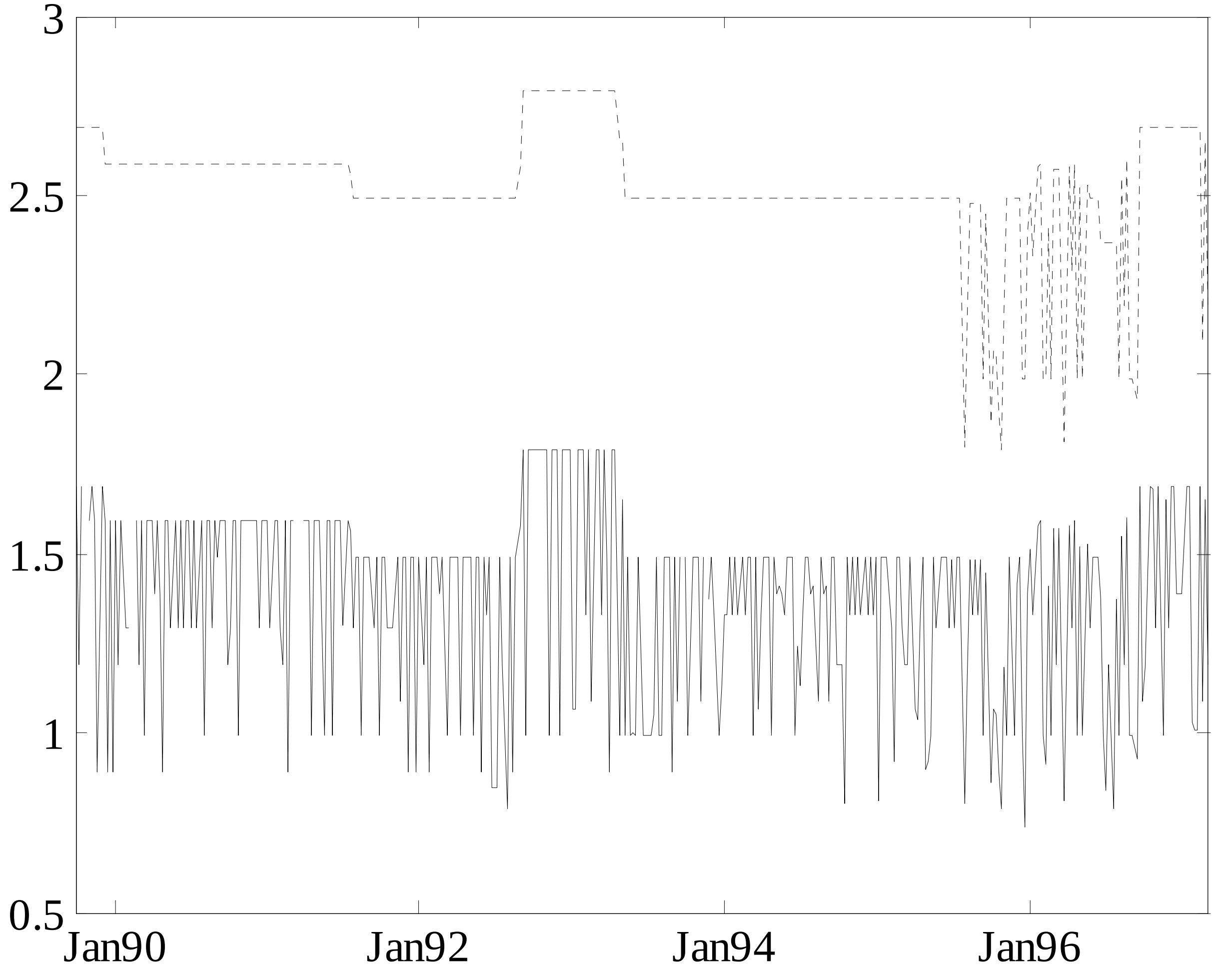
Monash University	procurement	procurement of information technologies	Oct-04		The Universit requires that Suppliers provide a firm price period of at least twelve (12) months from the date of execution of a formal agreement…During the firm price period the Supplier guarantees not to increase prices….
Harvard University	procurement	office products procurement from Staples	1/1/2005	*	Information based on an interview with the Harvard procurement manager: Staples prices fixed during the year for top 200(?) products

Figure 1: Nabisco Premium Saltines 16oz



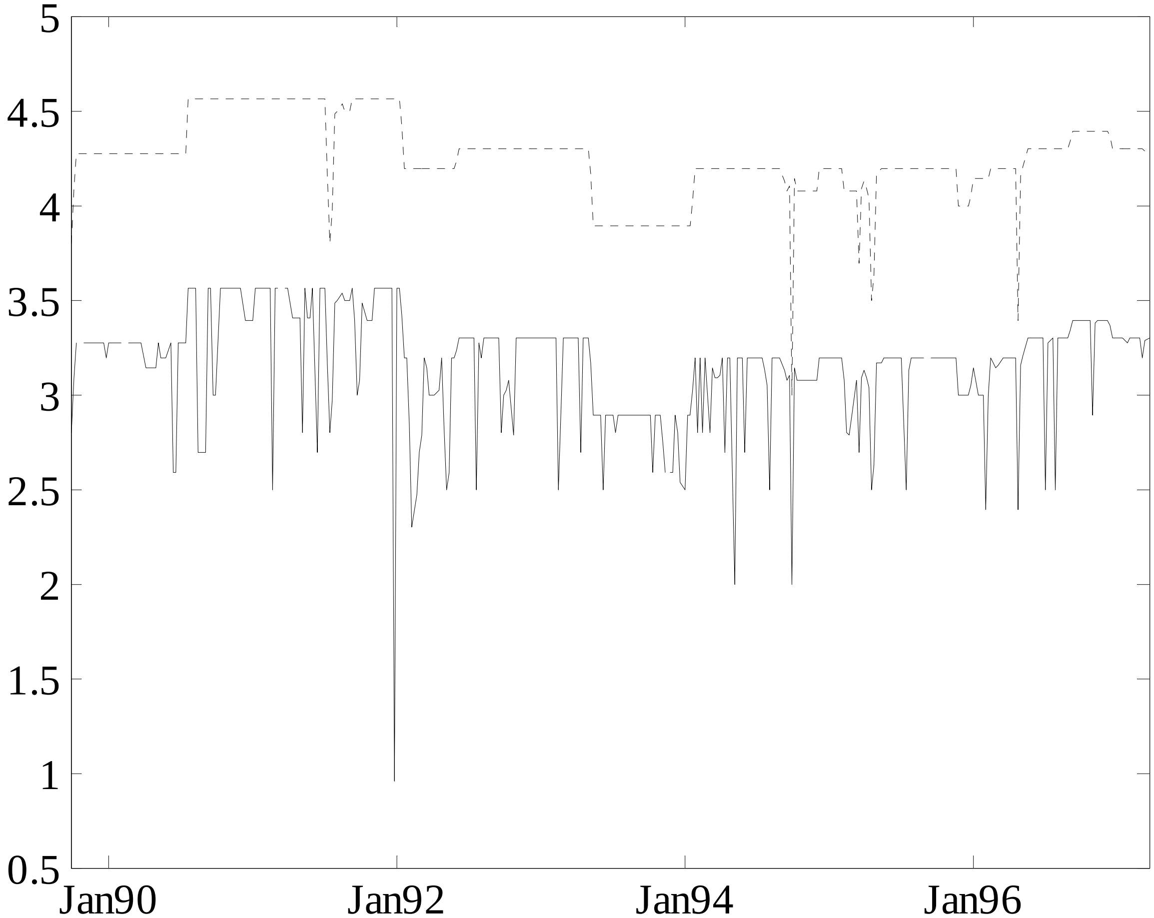
The solid line is the price of Nabisco Premium Saltines. The dotted line is the regular price of Nabisco Premium Saltines shifted up by $1.

Figure 2: Diet Coke 2L



The solid line is the price of Diet Coke 2L. The dotted line is the regular price of Diet Coke 2L shifted up by $1.

Figure 3: Kraft Singles 16oz



The solid line is the price of Nabisco Premium Saltines. The dotted line is the regular price of Nabisco Premium Saltines shifted up by $1.