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Precautionary price stickiness ☆

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ABSTRACT

This paper proposes a model in which retail prices are sticky even though firms can always change their prices at zero cost. Instead of imposing a "menu cost", we assume that more precise decisions are more costly. In equilibrium, firms optimally make some errors in price-setting, thus economizing on managerial time. Both the time cost of choice, and the resulting risk of errors, give firms an incentive to leave their prices unchanged until they perceive a sufficiently costly deviation from the optimal price. We show that this error-prone "control cost" framework helps explain many puzzling observations from microdata. However, on the macroeconomic side, pricing errors do little to explain the real effects of monetary shocks.

1. Introduction

Economic conditions change continually. A firm that attempts to maintain an optimal price in response to these changes faces at least two costly managerial challenges. First, it must repeatedly decide when to post new prices. Second, for each price update, it must choose what new price to post. Since both decisions are costly, managers may suffer errors or frictions along either margin. Most familiar models of nominal rigidity have studied frictions in the first decision, assuming that price adjustments can only occur intermittently, either with exogenous frequency (as in Calvo, 1983) or with endogenous frequency (e.g. Golosov and Lucas, 2007; Dotsey et al., 2013; Costain and Nakov, 2011a,b). This paper instead explores the effects of frictions in the second decision. In other words, we assume that firms can adjust their prices costlessly at any time, and that they adjust if and only if it is optimal to do so, but that whenever they adjust, their price choice is subject to errors.

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We study the implications of frictions along this margin both for microeconomic price adjustment data and for macroeconomic dynamics.

The key assumption of our model is that making precise decisions is costly. In the language of game theory, we assume price setting is subject to "control costs" (see for example Van Damme, 1991).[1] This means that while a firm could in principle adjust its price without paying any cost, its adjustment would then exhibit maximal randomness. If instead the firm pays a managerial cost, it can set its price more precisely, with less error. Therefore, while in equilibrium firms choose to pay a cost when they update prices, it is not a "menu cost" in the sense of resources devoted to the physical task of posting the new price. Instead, it is a cost of managerial decisions, consistent with the evidence of Zbaracki et al. (2004).

Note that there are many possible ways of measuring precision, so there is more than one way of implementing the control cost assumption. For concreteness, we measure precision in terms of entropy. When decision costs are proportional to entropy reduction, then as various authors have shown (including Stahl, 1990; Matejka and McKay, 2015) the distribution of price adjustments takes the form of a multinomial logit. Our model nests full frictionless rationality as the limiting case in which the firm sets the optimal price with probability one every period. The general equilibrium of the model is a logit equilibrium (McKelvey and Palfrey, 1995, 1998): the probabilities governing any firm's price choices are given by a logit function which depends on the value of each alternative price; moreover, the value of each alternative is determined, in equilibrium, by the logit choice probabilities of other firms.[2]

The fact that precision is costly gives rise to price stickiness, for two reasons. First, because they fear they may "tremble" when choosing a new price, firms may refrain from adjusting, on precautionary grounds, even when their current price is not exactly optimal. Whenever the firm's price is sufficiently close to the optimum, it prefers to "leave well enough alone", thus avoiding the risk of making a costly mistake. Second, firms know that when they make an adjustment, they should devote some time to choosing which price to set.[3] This managerial cost also deters price adjustment, just as a menu cost would. For both these reasons, behavior has an (S,s) band structure, in which adjustment occurs only if the current price is sufficiently far from the optimum.

Summarizing our main findings, our model is consistent with several "puzzling" stylized facts from micro price adjustment data. It implies that many large and small price changes coexist (Midrigan, 2011; Klenow and Kryvtsov, 2008; Klenow and Malin, 2010).[4] It also implies that the probability of price adjustment decreases over the first few months, and then remains essentially flat (Nakamura and Steinsson, 2008; Klenow and Malin, 2010).[5] Third, we find that the absolute size of price changes is approximately constant, independent of the time since last adjustment (Klenow and Malin, 2010).[6] Fourth, "extreme" prices are more likely to have been recently set than are prices near the center of the distribution (Campbell and Eden, 2014). Fifth, log retail prices vary more than the log of the replacement cost of those retail goods (Eichenbaum et al., 2011). Sixth, the standard deviation of price adjustments has little relation with the inflation rate, consistent with Gagnon (2009).[7] While a variety of explanations have been offered for some of these observations (including sales, economies of scope in price setting, and heterogeneity among price setters), our framework matches all these facts in a very simple way, using only one degree of freedom in the parameterization.

Finally, we study the effects of money supply shocks, using numerical methods for calculating dynamic general equilibrium in heterogeneous agent models. Given the degree of rationality that best fits microdata, the effect of money shocks on consumption in our model is very similar to that in the Golosov and Lucas (2007) fixed menu cost setup. The impact on consumption is much weaker than it is in the Calvo model, because of a strong "selection effect". That is, following a positive money growth shock the distribution of adjusting firms shifts: some near the upper (S,s) band that were contemplating a large price decrease are discouraged from adjusting, while others near the lower (S,s) band cross into the action region and choose a large price increase on average, making the aggregate price level quite flexible. Thus, this model of error-prone price adjustment fits microdata better than a fixed menu cost model, but implies that the macroeconomy is relatively close to monetary neutrality.

1.1. Related literature

Early sticky-price frameworks based on "menu costs" were studied by Barro (1972); Sheshinski and Weiss (1977), and Mankiw (1985). General equilibrium solutions of these models have only been attempted more recently, at first by ignoring idiosyncratic shocks (Dotsey et al., 1999), or by strongly restricting the distribution of such shocks (Danziger, 1999; Gertler and Leahy, 2008). Golosov and Lucas (2007) were the first to calculate the equilibrium effect of a money supply shock in a

[1] The control cost concept is also familiar in the engineering literature, especially that on machine learning; see Todorov (2009).

[2] Note, however, that since firms are infinitesimal, there are no strategic considerations in their price-setting decisions.

[3] To distinguish the effects of precaution, *per se*, from those of costly decisions, *per se*, in a working paper version (CEPR DP9912, 2014) we also reported an alternative specification that allows us to decompose the two. The alternative model directly assumes that the distribution of prices takes the form of a logit. The logit is simply imposed exogenously, and no managerial costs are subtracted out of the value function.

[4] This contrasts with the implications of the standard fixed menu cost model.

[5] In contrast, the price adjustment hazard in a menu cost model is initially strongly upward sloping.

[6] The Calvo model implies instead that price changes are increasing in the time since last adjustment.

[7] In the fixed menu cost model the fraction of price changes that are positive converges rapidly to 100% as inflation rises, causing the standard deviation of price adjustments to collapse.