The Frequency and Costs of Individual Price Adjustment

Alexander L. Wolman

The concept of "sticky prices" has been one of the most common explanations for the perceived importance of monetary policy since at least as far back as the 1930s. Simply put, if nominal prices for individual goods do not continuously adjust to economic conditions, then it is natural to think that monetary policy can influence the level of real economic activity through its ability to determine the nominal quantity of money. In evaluating whether this channel for monetary policy is important, two sets of research questions are relevant. First, do individual prices indeed change infrequently, and if so, why? Second, within macroeconomic models, what are the aggregate implications of the pricing behavior found in the data, and are those implications consistent with aggregate economic data? This article reviews research on the first set of questions in the hope of deriving lessons useful for improving the macroeconomic models that can address the second set.[1]

Weiss (1993) and Wynne (1995) have written surveys on similar topics. Weiss promotes the importance of infrequent price adjustment, whereas Wynne is a skeptic. This article differs from their work in that it covers the many papers that have appeared since 1995 and provides a history of thought perspective on theories of infrequent price adjustment. Much of my previous research has involved sticky price models, so I have a stake in what the evidence reveals.

[1] I do not consider infrequent nominal wage adjustment. Loosely, the parts of my paper that refer to repeated relationships can be thought of as applying to wages as well as prices.

Table 1 Summary of Empirical Studies

Object of Study	Authors
Retailers	Lach and Tsiddon; Rátfai; Slade; Levy et al.; Dutta et al.
Periodicals	Mussa; Weiss; Cecchetti; Willis
Industrial Products	Carlton; Zbaracki et al.
BLS Averages for Wholesale Prices	Mills; Means
Goods in Catalogs	Kashyap
Large Number of Firms (through surveys)	Blinder et al.; Buckle and Carlson; Carlson; Hall, Walsh, and Yates

Research on price stickiness has involved continual interplay between theory and empiricism. The early empirical studies discussed below approach "pure" empirical exercises. Research was not conducted in a vacuum, but these studies seem to have only broad theoretical motivation, and—initially—the results were not used to support particular theories. Subsequent theories of pricing behavior were developed and refined; the theory of explicit "menu" costs of price adjustment has been most sharply refined. Most of the empirical work I survey was conducted with this theory as its organizing framework. However, I also describe recent empirical work that takes a more naive approach, studying the pricing process at a large industrial firm. Together with two surveys of firms' pricing behavior, this recent work relates to several less-refined theories of infrequent price adjustment. Table 1 lists the empirical studies I survey.

Prices do change infrequently for many retail transactions. Furthermore, price adjustment behavior appears to be consistent with explicit, direct costs of changing prices. Evidence of infrequent price changes also exists for nonretail transactions, but the costs associated with price adjustment are not as easy to pin down. New evidence, supplementing years of conjecture, suggests that these costs involve the repeated nature of many buyer-seller relationships. The main challenges ahead are to improve both measurement, so that we better understand the nature of buyer-seller relationships, and theory, to study the macroeconomic implications of such relationships. It is not clear that conclusions about monetary policy based on direct costs of price change will carry over to models where infrequent price change results partly from repeated relationships.

1. MILLS'S DATA AND "ADMINISTERED PRICES"

Frederick Mills (1927) published what may be the first study of the frequency of price changes. He documented the behavior of wholesale price quotations for more than two hundred goods, using data from the Bureau of Labor Statistics' wholesale price bulletins covering the period from 1890 to 1926. The broad range of goods in Mills's book makes it a valuable source: he covers everything from cotton yarn ("Carded, white, mulespun, northern, cones, 10/1") to doorknobs ("Steel, bronze-plated"). A drawback to Mills's data, however, is that it is stated at a monthly frequency, with the monthly observations either taken one day per month or as an average of daily or weekly observations. Some of the measurements of price-change frequency are thus inaccurate, although prices that change less than once per month must be fairly accurately represented. Furthermore, the data on many of the goods were *averages* of observations from multiple price reporters—BLS field workers who recorded prices.

Mills's basic finding is that the frequency of price changes varies widely across goods: Excluding the years 1914–1921, roughly one-fifth of the goods changed price in less than 10 percent of months, while another one-fifth changed price in more than 90 percent of months. Mills pointed out that the distribution of price-change frequencies was bimodal (U-shaped), but did not speculate on the causes or implications of his findings. In reviewing Mills's book, John Maynard Keynes (1983 [1928], p. 226) wrote, "[i]t is the peculiarity of Mr. Mills that he starts without any theories and ends without any, being content to set out his material for the benefit of those who have less taste than he has for laborious investigation, and more taste for theorising." Keynes surely was one who had a taste for "theorising," but his review simply summarizes parts of the book, emphasizing dispersion in relative prices more than the frequency of price changes.

It was up to Gardiner Means, in 1935 an adviser to the U.S. Secretary of Agriculture, to impose an interpretation on Mills's material. Means's data is similar to that studied by Mills except that it is for the years 1926–1933—a period covering the early part of the Great Depression. Not surprisingly, that data has the same bimodal distribution for the frequency of price change noted by Mills. Means provided an interpretation that relied heavily on this feature of the data: "There are two essentially different types of market in operation—the traditional market in which supply and demand are equated by a flexible price and the administered market in which production and demand are equated at an inflexible administered price" (Means 1935). Means went on to argue that inflexible, administered prices had grown in importance as the economy had become more industrialized and were largely responsible for the severity of the Great Depression.

The "administered price" thesis spurred a voluminous literature, and Means became known as "one of the most influential economists in the history of

this country" (Stigler and Kindahl 1973, p. 717). Although Means's theory evolved over the years, it never clearly defined administered prices. Stigler and Kindahl wrote that "Means' theory has indeed become difficult to refute or confirm. . . . The implications have become so broad as to be almost uselessly vague" (1973, p. 719). Even the fundamental observations that drove Means's theorizing were shown to be suspect or false. First, Tucker (1938) used other data sources to argue that prices changed less frequently in the nineteenth century than during the 1929–1933 period. Second, Scitovszky (1941) pointed out that the U-shaped distribution of price-change frequencies was an artifact of the data format. Both Mills's and Means's data were monthly, so any prices that changed more than once per month were recorded as changing monthly; had they been recorded at, say, daily frequency, one end of the distribution would have flattened out. A similar argument can be made for the other end of the distribution, although Scitovszky did not discuss it. Any price that did not change during the sample period is treated identically, whereas if the sample were long enough, many of these items would be seen to have different frequencies of price change.

Although the bimodal distribution was spurious, Means was correct in pointing out that many prices change infrequently (he found this to be the case even for many goods that had more than one reporter). Furthermore, while Means did not clearly define "administered prices," it may be a useful term. The prices of many goods are changed only as a result of conscious decision by an individual or group of individuals, that is, by administration. And one would expect that "administrative costs" might lead to infrequent price change. In the next section I summarize a mature literature that makes explicit one narrow form of administrative costs. Subsequently, I will discuss a nascent literature that can be interpreted as resurrecting a richer notion of administered prices and studying the process of administration.

2.   EXPLICIT COSTS OF PRICE ADJUSTMENT

The best-developed theory of infrequent price changes is also the simplest. This theory combines some monopoly power on the part of firms with explicit physical costs of changing nominal prices. Because these costs are usually assumed to be fixed (independent of the magnitude of the price change), they are often referred to as "menu costs." Firms with monopoly power have leeway to choose the price of their products. The physical costs of changing prices will make firms choose to change prices infrequently as long as the costs have a significant component that is fixed, or sufficiently concave in the size of the price change.[2] The idea behind this theory is straightforward, so

---

[2] If there are costs of changing prices, but those costs are convex in the size of the price change, then firms will choose to change their prices a little bit every chance they get rather than waiting to adjust. See Rotemberg (1983).

there is a large body of work analyzing its implications. The theoretical work has led to empirical work studying both the length of time prices are fixed and the costs of changing prices. As a form of administrative costs, menu costs are distinguished in that they are mechanical: firms can be thought of as contracting out the printing of menus, knowing exactly what the cost will be.

The Theory

Robert Barro (1972) was the first to study a formal theoretical model of a firm facing explicit fixed costs of changing its price. According to Barro, "Shifts in price involve direct administrative costs to the producer (seller). . . . The administrative costs associated with price changes are straightforward, and can reasonably be described as a lump sum amount, independent of the size or direction of adjustment" (1972, p. 21). Sheshinski and Weiss (1977, 1983, 1992) made important contributions to understanding the behavior of firms facing fixed costs of price adjustment, as did Danziger (1987, 1988) and Kuran (1983). Caplin and Spulber (1987) initiated the formal analysis of the effects of monetary policy in models with fixed costs of price adjustment, and surprisingly they found that although costs of price adjustment made firms change their prices infrequently, the price level moved one-for-one with the money supply, implying monetary neutrality. Subsequent developments by Caplin and Leahy (1991, 1997), Caballero and Engel (1993), Dotsey, King, and Wolman (1999), and Danziger (1999) suggest that Caplin and Spulber's finding is not robust, i.e., that monetary policy can and generally does have real effects in menu-cost models.[3] While these articles have extended Barro's analysis in important ways, they have all maintained the basic assumption that there is a direct cost to firms of changing the nominal price of products they sell.

   Although no one until Barro incorporated the idea into a formal model, economists discussed explicit costs of price adjustment as early as the 1930s. Note that Barro uses the term "administrative costs." Explicit costs of price adjustment do not appear in Means's written work, but in a 1936 article John Kenneth Galbraith referred to private communication with Means that indicates Means—and Galbraith—thought about menu-type costs:

> Professor Gardiner C. Means has drawn my attention to the cost of making a price change under modern conditions as an incentive to the holding of prices constant. A concern with nation-wide sales outlets must make certain that dealers are informed of the change; it must distribute new price schedules and provide safeguards against "leaks" as well as risk a temporary cessation of business in case there is such a "leak." It must

---

[3] This is not an exhaustive list of references.

also recast its advertising to acquaint the public with the change. All of these things cost money and all of this expenditure is avoided if prices are allowed to stay where they are. (p. 470)

Galbraith describes a rich array of costs in this paragraph. The cost to "distribute new price schedules" corresponds most closely to the menu-type cost incorporated in most theoretical work since Barro; other costs Galbraith describes have a different flavor, and I return to them below. Another early reference to costs of price adjustment can be found in Scitovszky (1941). He writes that "the adjustment of price policies and of production often involves high subjective costs—not only for administrative and technical but also for political reasons." He then cites a 1935 survey article on monopoly theory by John Hicks as a source for the idea of administrative and technical costs. The relevant passage from Hicks reads, in part, "[T]he variation in monopoly profit for some way on either side of the highest profit output may often be small ... and if this is so, the subjective costs involved in securing a close adaptation to the most profitable output may well outweigh the meagre gains offered" (1935, p. 8). Hicks's argument is framed in terms of output, but it is clear that a similar argument could be made based on price.

Hicks anticipates arguments made by Akerlof and Yellen (1985a, b) and Mankiw (1985). Like Hicks, these authors note that the nature of optimal behavior often implies that small deviations from optimality will have a small effect on a monopolist's profits. A small cost of adjusting price may then make it optimal for a firm to keep its price fixed for several periods. This is precisely the idea that has been formalized in the literature initiated by Barro (1972), and Hicks came close to elucidating it in 1935. The unique contribution of Akerlof and Yellen and Mankiw was to show that under certain conditions, the implications of small costs to individual firms could be large for the economy as a whole.

Models in which there are explicit costs of price adjustment have three main empirical implications. First, trivially, there are explicit costs to changing individual prices, and because of these costs prices will not be changed continuously. Second, individual prices will change more frequently when the benefits to adjusting price are high or the costs are low. And third, the frequency of price adjustment should be high (low) when the inflation rate is high (low) because inflation causes the benefit to changing prices to rise over time. Many empirical studies have been motivated by menu-cost-type models of costly price adjustment, and they focus primarily on these main implications.

Empirical Evidence from High Inflation Episodes

Several authors have studied individual price data generated under conditions where there is great variation in the inflation rate. Such data are especially

interesting for evaluating menu-cost models because of the predicted positive relationship between inflation and the frequency of price change.

Mussa (1981) and Weiss (1993) describe newspaper prices during 1920s German hyperinflation. Between 1920 and 1923, as the German inflation rate rose to more than 10,000 percent per month, the cover prices of three newspapers changed with increasing frequency; however, even in the months of highest inflation those prices appear not to have changed every day.[4] Weiss also describes the behavior of an Israeli newspaper's price during a period of rising inflation from 1972 to 1984, and one sees the same qualitative features as in the German data. A drawback to looking at data on daily newspaper prices is that single copy sales of newspapers are not the only source of revenue associated with a newspaper. It is possible that subscription prices were indexed to inflation, and advertising may have been an important source of revenue. Presumably, though, some copies of the newspaper were indeed purchased at the printed price, so the behavior of that price does provide support for the existence of costs of price adjustment.

In a series of papers beginning in 1992, Saul Lach and Daniel Tsiddon study the behavior of the prices of 26 foodstuffs at grocery stores in Israel, during three subperiods between 1978 and 1984. As with newspapers in Israel during roughly the same period, food prices were changed infrequently, and the frequency responded to the overall inflation rate. As inflation rose from a 4.9 percent monthly rate in 1978–1979 to a 6.6 percent monthly rate during the 1981–1982 subperiod, the average duration of a price fell from 2.2 months to 1.5 months. These basic facts on the duration of price quotations are presented in Lach and Tsiddon (1992); in that article and their 1996 papers the authors also provide some deeper insights into the implications of their data. Among the features of the data they discuss is the distribution of relative prices. Caplin and Spulber's early menu-cost model generates a uniform distribution of prices, whereas Lach and Tsiddon find a unimodal distribution. This finding does not mean that Lach and Tsiddon's data are inconsistent with menu-cost models; more general models, such as that in Dotsey, King, and Wolman (1999), generate nonuniform distributions. However, even Dotsey, King, and Wolman's model would need to be extended—for example, with additional firm-specific shocks—to generate the type of distributions found by Lach and Tsiddon.[5] For some goods, they find that there are small price changes, but

---

[4] Weiss's data are in the form of a time series plot, for the newspapers *Germania* and *Tageblatt.* These data end in July 1923. Mussa displays the dates of price changes for the *Neue Preussische Zeitung*, for the period ending November 17, 1923, close to the date of monetary reform.

[5] The difficulty is that Lach and Tsiddon find nearly symmetric distributions, whereas Dotsey, King, and Wolman's model predicts that in an inflationary world the mode should be at the highest price charged. Eden (forthcoming) also analyzes Lach and Tsiddon's data. He argues that the relationship between relative price variability and inflation in the data is inconsistent with Dotsey, King, and Wolman's model.

the average price change for a given store is not small (1996b). Evidence of many small price changes would typically be seen as conflicting with menu-cost models, but Lach and Tsiddon argue that this evidence is consistent with models where the cost incurred is for changing the entire *menu* of a store's prices. And indeed, they find that price changes are generally synchronized within a firm, but not for a given good across firms (1996a).

Rátfai (2000) studies the behavior of meat prices in Hungary. His data cover 14 specific products sold in 8 stores from 1993 through 1996. Observations are at the monthly frequency. During this period annual CPI inflation in Hungary varied between 16 percent and 30 percent. The average duration of the meat price quotations was three months. Another measure of price change frequency is that in 58 percent of the observations, price was unchanged from the previous month. Rátfai provides data on both the overall inflation rate and different measures of the frequency of price adjustment over time. The data show a positive relationship, as predicted by theory. Rátfai also provides a detailed description of the distribution of price changes by size. His data appear consistent with fixed costs of price adjustment in that one does not observe many tiny adjustments.

Empirical Evidence from Moderate Inflation Eras

Menu-cost models make sharp predictions about periods in which the average inflation rate changes dramatically. Periods when inflation is moderate and relatively steady lend themselves to different analysis. One can still measure the frequency of price adjustment and the distribution of price changes. Menu-cost models predict that price changes will be infrequent and large rather than frequent and small, but this prediction needs to be qualified in light of Lach and Tsiddon's analysis of multiproduct firms. In effect, their work teaches us that it will be difficult to reject menu-cost models; evidence of small price changes does not necessarily mean that menu costs are unimportant. In addition to documenting the behavior of individual prices, researchers have also attempted to measure menu costs, both directly and indirectly.

Of all the studies of price adjustment frequency from data generated under moderate inflation, Anil Kashyap's (1995) analysis of prices in catalogs covers the longest period of time, from 1953 to 1987. Kashyap traces the prices of 12 items in total from L.L.Bean, Orvis and REI catalogs. Some of the items were sold during the entire 35-year period, while others were sold for as little as 12 years of the sample. All of these merchants fix their catalog prices for a minimum of six months at a time, but prices of the 12 items in Kashyap's study changed even less frequently. The Orvis binoculars changed price most frequently—every 11.2 months on average—and the Orvis fishing fly changed price least frequently—every 30.4 months. Even the items that changed prices relatively frequently on average had lengthy episodes without a price change.

The aforementioned binoculars went for 42 months from 1968 to 1971 without a price change, and the L.L.Bean camp moccasin—which had a price change every 11.5 months on average—went for 78 months without a price change from 1959 to 1965. Kashyap also finds that there are many examples of small price changes. Given Lach and Tsiddon's findings regarding synchronization across and within firms, it is interesting to know what Kashyap's data reveal along these lines. Overall, he finds little evidence of synchronization in price changes; however, there are too few goods per catalog in his study to reach robust conclusions about synchronization within a catalog. Kashyap's findings are somewhat troubling with respect to standard menu-cost models. Each of the firms chooses to incur a menu cost (print a new catalog) twice per year. Standard models would predict the cost being incurred only when optimal. It seems clear, though, that the complicating factor for catalog retailers is that the menu cost is incurred in conjunction with marketing activities, and marketing, as opposed to price changes, may be the dominant factor in determining the semiannual frequency.

John A. Carlson (1992) uses data from a quarterly survey conducted by the National Federation of Independent Business, covering the years 1979–1990. He presents both prospective and retrospective information on firms' price-changing behavior. The prospective information is in the form of responses to the question, "In the next three months, do you plan to change the average selling price of your goods and/or services?"[6] Retrospectively, firms are asked, "How are your average selling prices now compared to three months ago?" In the first two years of the sample, when inflation was relatively high, between 30 percent and 45 percent of firms reported that their prices had remained constant and had been expected to remain constant over the previous three months. As predicted by the existence of menu costs, in the lower inflation period from 1983 to 1990, these numbers stabilized at a higher level: between 55 percent and 75 percent of firms reported constant actual and expected prices over the prior three months.

Robert A. Buckle and Carlson (2000) report on a similar survey conducted by the New Zealand Institute of Economic Research. The *Quarterly Survey of Business Opinion* asks executives of manufacturing and building firms whether the direction of price change in the last three months has been up, same, or down. For all firms in the survey, the average duration of a price is reported to be 6.7 months. The authors also split up their sample by firm size. They find that the smallest firms in the sample keep their prices fixed on average for 50 percent longer than the largest firms. Those estimates are probably imprecise. Survey respondents are generally considering the price of more than one product, so their responses may reflect these products' average behavior. The

---

[6] See Carlson (1992, p. 325).

category "unchanged" may be chosen for average changes that are considered
small. Nonetheless, it is notable that small firms seem to keep their prices
fixed longer. Buckle and Carlson argue that this suggests that costs of price
adjustment do not vary much across firms: large firms reap a greater benefit
from adjusting their price and hence adjust more often.

Stephen Cecchetti (1985, 1986) documents the behavior of 38 U.S. mag-
azine cover prices between 1953 and 1979. The prices are measured annually,
with the first issue of each year. From year to year, the number of maga-
zines that changed their price ranges from 3 percent of the total, in 1953, to
50 percent of the total, in 1974. In the 1950s (1953–1959), 12 percent of
the magazines changed their price in an average year, while in the 1970s—a
period of higher inflation—30 percent of the magazines changed their price
in an average year. Cecchetti's evidence is thus both consistent with the evi-
dence on newspaper prices in Germany and Israel and, because magazines sell
subscriptions and advertisements, subject to the same caveat. Cecchetti goes
beyond simple descriptive statistics to estimate a complicated price-setting
model. While his estimates are consistent with the existence of menu costs,
he concludes that menu costs are not the whole story. The total costs of price
adjustment depend on the size of the price change. This finding is consistent
with the idea of "customer costs" of price adjustment, which are discussed
below.

Willis (2000) uses Cecchetti's magazine price data to estimate the menu
costs of price adjustment. His estimation method begins by specifying an ex-
plicit intertemporal optimization problem for each magazine. Next, reduced-
form hazard functions are estimated, which represent the probability of a price
change as a function of a small number of aggregate and magazine-specific
variables. Then, an indirect inference procedure is used to match up the
reduced-form estimates with structural parameters. Willis finds that the aver-
age adjustment cost is 4 percent of revenues. I have already discussed the fact
that magazines generate revenue from subscriptions and advertising, as well as
single-issue sales. It is difficult to interpret Willis's results because ad market-
ing and price discrimination between subscribers and newsstand purchasers
may influence the cover-pricing decision. Nonetheless, Willis's method is a
promising one.

Slade (1998) combines a dynamic model of optimal price setting with
sophisticated econometric methods to estimate the costs of price adjustment
for particular goods. She uses weekly data for 1984–1985 on saltine prices
and sales at ten supermarkets. Price setters face profit maximization problems
similar to those studied in the literature following Barro (1972) except that
there is a role for "goodwill" in their decisions. Goodwill enters the demand
function faced by firms, and it rises and falls according to whether price is
above or below a "normal" level. Slade's estimation framework allows for
both fixed and variable components of price adjustment costs, and the costs

being estimated represent all costs of price adjustment. That is, the theoretical framework maintains that there are fixed and variable costs of price adjustment, and it does not break down those costs according to whether they are menu costs or anything else. Slade reports that price remains unchanged about 80 percent of the time. She estimates that the average cost of a price change for a box of saltines is $2.72, with 94 percent of those costs fixed with respect to the size of the price change. When broken down by store, the average fixed costs range from $2.17 to $3.09, and when broken down by brand, they range from $2.15 to $2.68. A national chain has the lowest costs, an independent store has the highest costs, and two regional chains are in the middle.[7]

Two recent papers on individual price adjustment are concerned mainly with measuring the costs of price adjustment, although both provide some information on the frequency of price adjustment for individual goods. Levy et al. (1997) and Dutta et al. (1999) study price adjustment at supermarkets and drugstores, respectively. In both cases, the data source is a company that sells electronic shelf-label systems. As part of its sales effort, the company has undertaken detailed studies of the pricing practices of some of its potential customers. Included in the studies is information on both the frequency and the costs of price adjustment.

Levy et al. find that four supermarket chains change the prices of approximately 16 percent of their products each week, while a fifth chain only changes the prices of 6 percent of its products each week. The chain with fewer price changes also happens to be located in a state that requires each item to carry its own price tag—which raises the cost of price adjustment. Because the sales pitch of the electronic shelf-label system's manufacturer promises in part to save retailers money on their pricing process, we might expect the manufacturer's estimates of the direct costs of price adjustment to be too high. In each case, however, the estimates were reviewed by the retailers themselves, who apparently did not strongly disagree with the manufacturer.[8] On the other hand, we should not expect good estimates of any costs of price adjustment other than menu costs from these studies: the manufacturer of electronic labeling systems has no incentive to measure additional costs. To the extent that other costs of price adjustment are high, the benefits of reducing the direct costs of price adjustment will be smaller. The retailer would save on the existing amount of price adjustment, but might not choose to significantly increase the frequency of its price adjustment.

Levy et al. report that the physical costs of price adjustment average 0.70 percent of store revenues. Profit margins are small in the supermarket

---

[7] In Slade's paper, it is the manufacturers that are setting price. The statement that "a national chain has the lowest costs," for example, means that the manufacturer's cost of changing price at that chain are lower than at other chains.

[8] The electronic shelf-label system illustrates that technology affects the costs of price adjustment.

industry—the authors assume an average of 2 percent—meaning that menu costs are estimated to be 35 percent of profits. They also estimate that changing the price of a specific item costs 52¢ on average for four of the chains in their sample and $1.33 for the fifth chain. As mentioned above, the fifth chain is subject to laws requiring that all items carry price tags, and it changes prices much less frequently than the others. More than 70 percent of the costs of changing price are labor costs. The source data for this study do not include information about the head office managerial costs of price adjustment. However, based on their own knowledge of this industry, the authors estimate these managerial costs at 6.8 percent of the total costs of price adjustment. It is notable that estimated cost per price change is much lower for Levy et al. than for Slade. There are at least three potential explanations for this discrepancy. First, saltines may be items with particularly high menu costs; Levy et al. do not provide data on individual goods. Second, Levy et al. may not be measuring certain forms of price adjustment costs. Finally, Slade's model may be misspecified, resulting in cost estimates that are too high.

With respect to the drugstore chain, Dutta et al. find that prices change on 7.5 percent of the products in an average week. They report similar estimates of the costs of changing prices for drugstores to those found for supermarkets, with the direct costs of price adjustment estimated to be 0.74 percent of revenue and 27 percent of profits. Changing the price of a specific item is estimated to cost 42¢ on average. Based on these numbers, it is not clear whether one would describe menu costs as higher for supermarkets or drugstores. It is worth noting, then, that the frequency of price change is much lower in drugstores than in supermarkets. It must be that either unmeasured costs of price adjustment are higher for drugstores or the standard notion of profits is less sensitive to price for drugstores than for supermarkets.

A Skeptical View

The papers discussed in this section generally support the idea that prices are changed infrequently because of fixed costs of price adjustment. Like many of these studies, Carlton (1986) presents evidence that individual prices change infrequently. However, his preferred interpretation is not that there are physical costs to price adjustment.

Carlton's data set was compiled by George Stigler and James Kindahl. They used the data for a 1970 book that was in large part a critical response to Gardiner Means. The principal drawback to the BLS data analyzed by Mills and Means is that much of it is averaged over multiple sellers. For their book, Stigler and Kindahl gathered data from individual purchasers in industries similar to those studied by Means. They chose, however, to concentrate on the "goods-level" data rather than the transactions-level data. Carlton studied this same data at the level of the individual purchaser. The goods are intermediates

used in manufacturing. There are 11 different product groups, including steel, truck motors, glass, and cement. The average duration of price rigidity across the product groups ranges from 5.9 months (household appliances) to 19.2 months (chemicals). These data thus show strong evidence of infrequent price changes.

Long average intervals between price changes do not necessarily imply that fixed costs of price adjustment are important. Carlton shows that in the Stigler-Kindahl data there are many instances of small price changes, which is inconsistent with simple menu-cost models. Richer menu-cost models allow fixed costs of changing price to vary across firms, and Carlton acknowledges that this may be one factor in explaining the data. However, he also emphasizes a fundamentally different explanation, that "firms and buyers differ in their need to rely on the price system to achieve allocative efficiency" (1986, pp. 648–49). Carlton spells out this idea further in a 1989 essay, arguing that price adjustment alone is a good way to clear markets for some homogeneous goods. For other goods, especially in the presence of long-term relationships, efficient allocations may be achieved at lower cost by varying other characteristics, such as quality or delivery time. From this perspective, there is nothing special about adjusting price versus adjusting other characteristics. The observation that prices do not change frequently in a particular market tells us something about the nature of that market, but it does not necessarily imply that there are high physical costs of price adjustment.[9] Carlton's analysis is important to bear in mind when confronted with data about the frequency of price adjustment alone; however, his analysis must be weighed against those that actually measure price adjustment costs.

3.   ADMINISTERED PRICES REHABILITATED

Menu costs are one form of administrative price adjustment cost. Economists have been drawn to studying menu costs because it has been relatively straightforward both to measure them (in principle) and to incorporate them in rich dynamic models. However, the idea of menu costs overlooks the administrative *process,* which may be costly. It also ignores the possibility that firms may face *indirect* costs of changing their prices, related to the effect of a price change on consumer behavior.[10] A recent empirical paper by Zbaracki et al. (2000) studies costs of the administrative process and indirect

---

[9] The implications for monetary policy of Carlton's explanation for rigid prices are unclear. In the context of labor markets, Barro (1977) has argued that a similar explanation for infrequent (wage) adjustment overturns the idea that monetary policy has real effects. Without understanding the precise features of the market that lead nominal prices to go unchanged, however, this conclusion seems tenuous.

[10] These changes in consumer behavior represent something other than movement along a smooth demand curve, as will be seen below.

costs associated with changing customer behavior, as well as menu costs. As I describe this empirical work, I will give some more detailed background on the theoretical basis for indirect costs of price adjustment.

Zbaracki et al. report on an intensive analysis of a large industrial corporation that sells more than a thousand products. The authors studied this corporation for two years with the objective of learning about the firm's price-setting process. Their study follows a "'discovery oriented' perspective" and is geared toward understanding what the authors refer to as managerial costs and customer costs of price adjustment, as well as physical costs (2000, p. 4). In their terminology, physical costs correspond roughly to menu costs—they are costs of printing and distributing price lists, both hard copies and electronic versions. Managerial costs are those costs incurred during the long process—four months for this corporation—of choosing list prices for the upcoming year. Customer costs are divided into "hard" and "soft" costs; hard customer costs are similar to managerial costs, except that the former are incurred after list prices have been set. These costs involve communicating with customers regarding new prices. Soft customer costs are described as "potential harm to customer relationships and company reputation" (2000, p. 19).

The idea of soft customer costs recalls one of the costs listed by Galbraith, that of the risk of lost business. These costs are indirect, and the "risk of lost business" is the risk that even a small price change will cause a discrete shift in demand. Absent physical costs of changing price, such factors would still make it optimal for firms to keep their prices fixed in the face of small enough changes in demand and supply conditions. Although the idea of indirect costs was perhaps implicit in Means's work and the literature he inspired, clear statements can first be found in Sweezy (1939) and Hall and Hitch (1939). These authors developed the "kinked demand curve" theory of oligopoly. This theory posits that a decrease in price will not gain a firm very many customers, but an increase in price will cause it to lose many customers. Faced with this situation, a firm will choose to maintain a fixed price in response to modest changes in market conditions. Stigler (1947) cast doubt on the simple kinked demand theory but could not kill it. A large recent literature studies conditions under which models with consumer search imply that firms' demand curves will be endogenously kinked at some initial price.[11] Informal discussions of this idea can be found in Okun (1981); see Stiglitz (1989) for a discussion of the more technical literature. Because models of consumer search are relatively complicated, theorists have made less progress in studying the macroeconomic implications of "customer costs" than direct costs; see, however, Woglom (1982), Goodfriend (1997) and Benabou (1988, 1992). As for empirical work

---

[11] A major stumbling block in this literature has been the issue of how the firm's "initial price" is determined.

studying indirect costs of price adjustment, Zbaracki et al. is one of the few examples.

The firm studied by Zbaracki et al. has an annual price-setting cycle. Each month it sends out an updated pricing sheet, but very rarely does that sheet list changed prices. Although the goods at the industrial corporation of Zbaracki et al. are very different from the catalog items studied by Kashyap, in both cases the firms often choose not to change prices even when new "price lists" are distributed. The authors estimate the physical costs of price adjustment to be 0.04 percent of revenue and 0.7 percent of net margin. Managerial costs of price adjustment are 0.28 percent of revenue and 4.6 percent of net margin. Finally, hard customer costs of price adjustment are 9.1 percent of revenue and 15 percent of net margin.

Zbaracki et al. do not attempt to quantify soft customer costs, but they do provide a qualitative discussion of these costs, which is consistent with modern versions of kinked demand theory. According to a salesperson at the firm, "every time you have one of these price changes you have to go in there and you are opening a Pandora's box" (2000, p. 26). In other words, enacting a price change can have severe consequences for customer relationships.

Note that in Zbaracki et al., physical costs are only one-seventh as large as managerial costs, which sharply contrasts with the estimates for supermarkets, where Levy et al. report that physical costs are roughly nine times as large as managerial costs. On one level, it is perhaps not surprising that managerial costs are relatively higher for the industrial corporation. Supermarket chains have one headquarters supporting hundreds of retail outlets, and the physical costs of price changes must be incurred at every retail outlet. At the industrial corporation, there are no retail outlets, so physical costs are small. This explains why the ratio of managerial costs to physical costs should be larger for the industrial corporation than for the supermarkets. However, it does not explain why managerial costs should be so much larger *as a percentage of revenues* at an industrial corporation. This differential suggests that pricing is more difficult at the industrial company than at supermarkets. To the extent that the supermarket has numerous competitors with readily observable prices, perhaps it is not surprising that pricing is more difficult for the industrial corporation.

The most striking aspect of these numbers is the magnitude of the customer costs of price adjustment. Hard customer costs of price adjustment are 28 times as large as physical costs and managerial costs combined. Recall that there was no mention of customer costs in the studies of supermarkets and drugstores. In the latter industries, there are many customers, each of whom is small. Hence, essentially no resources are expended communicating with

customers on an individual basis.[12] In contrast, the corporation studied by Zbaracki et al. has only about 1,400 customers. Almost three hundred of the largest customers receive some individualized attention as the new price lists are introduced, and any of the customers will receive some attention from a salesperson if they complain about a price change.[13]

4.   SURVEY EVIDENCE

Blinder et al. (1998) and Hall, Walsh, and Yates (1997) have conducted large surveys of firms' pricing practices. These surveys sought quantitative information about the frequency of price adjustment, and qualitative information about the costs of price adjustment. In addition, the authors included questions in their surveys about whether different theories of price adjustment were deemed relevant.

Blinder et al.'s book describes the results of interviews the authors conducted with roughly two hundred companies.[14] The interviews were survey-like in that they consisted of a common set of questions for all firms. Many of the questions related to factors that influence firms' pricing behavior. Blinder et al. also asked the firms how often they changed their prices. This question seems to have been framed in a way that avoids the problem associated with Buckle and Carlson's (2000) survey data.[15] Blinder et al. asked, "How often do the prices of your most important products change in a typical year?" The median number of price changes per year is 1.4; 10 percent of firms change their prices less than once per year, 29 percent of firms change their prices between two and four times per year, and 22 percent of firms change their prices more than four times per year.

Blinder et al. also include questions aimed at ascertaining the nature of any costs of price adjustment. They describe 12 theories of price stickiness and ask firms to rate the importance of each one for their own pricing practices. Some of their theories, such as procyclical elasticity of demand, cost-based pricing, and constant marginal cost, relate not to infrequent price adjustment but to "small" price adjustment. The most notable finding is that 65 percent of firms report that they have implicit contracts with customers to keep prices constant. "Implicit contracts" is a term usually used in the context of employer-employee relationships. Blinder et al. use it to refer to the customer costs that they trace to Okun (1981). That so many firms in the survey emphasize implicit contracts highlights the importance of repeated relationships

---

[12] The Internet may be changing this, in conjunction with the large databases now available.

[13] Of course, supermarkets also respond to customer complaints, but it seems unlikely that a significant number of complaints are related to price changes.

[14] The titles of the interviewees ranged from Manager to CEO.

[15] In Buckle and Carlson's data, respondents may have been reporting averages across products.

in determining price behavior, for implicit contracts only arise when there are repeated relationships. Repeated relationships show up in other responses to the study as well: 38 percent of firms report having *explicit* nominal contracts with customers. Furthermore, one-quarter of the firms report that they were inhibited from changing prices because they would antagonize customers and thereby lose future sales.[16] As for the direct menu costs of price adjustment, these are stated to be important by more than 25 percent of the firms surveyed.[17]

Simon Hall, Mark Walsh, and Anthony Yates (1997) conducted a survey similar to Blinder et al.'s for the United Kingdom. They obtained written responses to a questionnaire from 654 companies. The question about frequency of price change was, "In the last twelve months, how many times have you actually changed the price of your main product?" Roughly 6 percent of firms responded that they had not changed their price in the last year, 44 percent changed their price between two and four times, and 14 percent changed their price more than four times.[18] Hall, Walsh, and Yates's survey includes some of the same questions asked by Blinder et al. about theories of pricing. However, they only ask firms whether various general theories are important for their own pricing practices, not about details related to specific theories. In comments on a preliminary paper by Blinder, Blanchard (1994, p. 150) criticizes "theory recognition" questions: "The image ... that recurs throughout my reading of the results is, that confronted with the twelve statements, the firms often had the reaction: 'Now that you say it, yes, maybe that *is* kind of what we do.'" If one is sympathetic to Blanchard's view, then some of Hall, Walsh, and Yates's results are quite striking. Several of the theories mentioned by Hall, Walsh, and Yates were recognized as relevant by *less than one-quarter* of firms, and the least recognized theory was that of physical menu costs, with only 7.3 percent recognition. As Blanchard notes, however, and as I have discussed above, theoretical work has shown that menu costs that are small from the firm's perspective may nonetheless have significant macroeconomic implications. Therefore, it is probably unwise to ignore evidence of small but widespread direct price adjustment costs gleaned from intensive studies solely because of the survey evidence.

5. CONCLUSIONS

The empirical research surveyed here leaves no doubt that the prices of many goods change infrequently (i.e., are sticky) relative to the frequency of changes

---

[16] The distinction Blinder et al. make between fear of antagonizing customers and implicit contracts is not clear.

[17] One quarter of the firms stated that there were physical costs to price adjustment. Many firms also reported managerial costs, but it is not possible to determine the amount of overlap between these two groups of firms.

[18] These numbers are approximate, as Hall, Walsh, and Yates provide graphical but not numerical frequency distributions.

in market conditions. I have, however, made no attempt to quantify a notion such as the GDP-weighted frequency of price adjustment, which would be a worthwhile endeavor. That prices do change only infrequently results from one form or another of costs of price adjustment.[19] The simplest type of price adjustment costs, physical menu costs, are easy to identify and straightforward to measure (though obtaining access to data may not be easy). These costs are nontrivial for retailers, but limited evidence for the industrial corporation studied by Zbaracki et al. suggests that menu costs may be quite small in other sectors. For the same industrial corporation, other administrative costs of price adjustment are quite large; these can be summarized as costs of the time it takes managers to choose prices. More observations about these costs from other firms would be valuable. The final form of price adjustment costs I have identified is more nebulous. Indirect customer costs involve a discrete shift in demand when a firm changes a price. There is a long theoretical tradition of studying such phenomena, but that tradition has not yet led to appealing macroeconomic models. Again, the work by Zbaracki et al. suggests that such costs do exist and that more work, both theoretical and empirical, is called for.

What do these findings tell us about macroeconomic modeling? It is an oversimplification to model all goods as symmetric with respect to price adjustment frictions. This has been the standard approach in recent research using sticky price models. Studying models where price adjustment is systematically less costly for some goods than others is straightforward. Incorporating long-term relationships in a way that can generate endogenous price rigidity, however, is a more important and less straightforward modeling extension.

─────────

REFERENCES

Akerlof, George A., and Janet L. Yellen. "Can Small Deviations from Rationality Make Significant Differences to Economic Equilibria?" *American Economic Review*, vol. 75 (September 1985), pp. 708–20.

──────────. "A Near-rational Model of the Business Cycle, with Wage and Price Inertia," *Quarterly Journal of Economics*, vol. 100 (Supplement 1985), pp. 823–38.

Backman, Jules, ed. *Price Practices and Price Policies, Selected Writings*. New York: The Ronald Press Company, 1953.

─────────

[19] Even Carlton's theory involves costs or price adjustment in a sense: It is more costly to vary price than other characteristics of a product.

Barro, Robert J. "Long-Term Contracting, Sticky Prices, and Monetary Policy," *Journal of Monetary Economics*, vol. 3 (July 1977), pp. 305–16.

_____. "A Theory of Monopolistic Price Adjustment," *The Review of Economic Studies*, vol. 39 (January 1972), pp. 17–26.

Benabou, Roland. "Inflation and Efficiency in Search Markets," *The Review of Economic Studies*, vol. 59 (April 1992), pp. 299–329.

_____. "Search, Price Setting and Inflation," *The Review of Economic Studies*, vol. 55 (July 1988), pp. 353–76.

Blanchard, Olivier J. "On Sticky Prices: Academic Theories Meet the Real World: Comment," in N. Gregory Mankiw, ed., *Monetary Policy*. Chicago: University of Chicago Press, 1994, pp. 150–54.

Blinder, Alan, Elie R. D. Canetti, David E. Lebow, and Jeremy B. Rudd. *Asking About Prices: A New Approach to Understanding Price Stickiness*. New York: Russel Sage Foundation, 1998.

Buckle, Robert A., and John A. Carlson. "Menu Costs, Firm Size and Price Rigidity," *Economics Letters*, vol. 66 (January 2000), pp. 59–63.

Caballero, Ricardo J., and Eduardo M. R. A. Engel. "Heterogeneity and Output Fluctuations in a Dynamic Menu-Cost Economy," *Review of Economic Studies*, vol. 60 (January 1993), pp. 95–119.

Caplin, Andrew, and John Leahy. "Aggregation and Optimization with State-Dependent Pricing," *Econometrica*, vol. 65 (May 1997), pp. 601–25.

_____. "State-Dependent Pricing and the Dynamics of Money and Output," *Quarterly Journal of Economics*, vol. 106 (August 1991), pp. 683–708.

Caplin, Andrew, and Daniel Spulber. "Menu Costs and the Neutrality of Money," *Quarterly Journal of Economics*, vol. 102 (November 1987), pp. 703–25.

Carlson, John A. "Some Evidence on Lump Sum versus Convex Costs of Changing Prices," *Economic Inquiry*, vol. 30 (April 1992), pp. 322–31.

Carlton, Dennis W. "The Theory and the Facts of How Markets Clear: Is Industrial Organization Valuable for Understanding Macroeconomics?" in Richard Schmalensee and Robert D. Willig, eds., *Handbook of industrial organization,* vol. 1. Amsterdam: North-Holland, 1989, pp. 909–46

_____. "The Rigidity of Prices," *American Economic Review*, vol. 76 (September 1986), pp. 637–58.

Cecchetti, Stephen G. "The Frequency of Price Adjustment: A Study of the Newsstand Prices of Magazines," *Journal of Econometrics*, vol. 31 (April 1986), pp. 255–74.

——————————. "Staggered Contracts and the Frequency of Price Adjustment," *Quarterly Journal of Economics*, vol. 100 (supplement 1985), pp. 935–59.

Danziger, Leif. "A Dynamic Economy with Costly Price Adjustments," *American Economic Review*, vol. 89 (September 1999), pp. 878–901.

——————————. "Costs of Price Adjustment and the Welfare Economics of Inflation and Disinflation," *American Economic Review*, vol. 78 (September 1988), pp. 633–46.

——————————. "Inflation, Fixed Costs of Adjustment and Measurement of Relative Price Variability: Theory and Evidence," *American Economic Review*, vol. 77 (1987), pp. 704–13.

Dotsey, Michael, Robert G. King, and Alexander L. Wolman. "State-Dependent Pricing and the General Equilibrium Dynamics of Money and Output," *Quarterly Journal of Economics*, vol. 114 (May 1999), pp. 655–90.

Dutta, Shantanu, Mark Bergen, Daniel Levy, and Robert Venable. "Menu Costs, Posted Prices, and Multiproduct Retailers," *Journal of Money, Credit and Banking*, vol. 31 (November 1999), 683–703.

Eden, Benjamin. "Inflation and Price Adjustment: an Analysis of Micro Data," *Review of Economic Dynamics* (forthcoming).

Galbraith, John Kenneth. "Monopoly Power and Price Rigidities," *Quarterly Journal of Economics*, vol. 50 (May 1936), pp. 456-75.

Goodfriend, Marvin. "A Framework for the Analysis of Moderate Inflations," *Journal of Monetary Economics,* vol. 39 (June 1997), pp. 45–65.

Hall, R. L., and C. J. Hitch. "Price Theory and Business Behavior," *Oxford Economic Papers* (May 1939), pp. 12–45.

Hall, Simon, Mark Walsh, and Anthony Yates. "How Do U.K. Companies Set Prices?" Bank of England Working Paper No. 67, July 1997.

Hicks, John R. "Annual Survey of Economic Theory: the Theory of Monopoly," *Econometrica*, vol. 3 (January 1935), pp. 1–20.

Kashyap, Anil K. "Sticky Prices: New Evidence from Retail Catalogs," *Quarterly Journal of Economics*, vol. 110 (February 1995), pp. 245–74.

Keynes, John Maynard. 1928 review of Frederick C. Mills, "The Behaviour of Prices," reprinted in *The Collected Writings of John Maynard Keynes*, vol. XI. London: Macmillan, 1983, pp. 225–28.

Kuran, Timur. "Asymmetric Price Rigidity and Inflationary Bias," *American Economic Review*, vol. 73 (June 1983), pp. 373–82.

Lach, Saul, and Daniel Tsiddon. "Staggering and Synchronization in Price Setting: Evidence from Multiproduct Firms," *American Economic Review*, vol. 86 (December 1996), pp. 1175-96.

——————. "Small Price Changes and Menu Costs." Manuscript. January 30, 1996.

——————. "The Behavior of Prices and Inflation: An Empirical Analysis of Disaggregated Price Data," *Journal of Political Economy*, vol. 100 (April 1992), pp. 349–89.

Levy, Daniel, Mark Bergen, Shantanu Dutta and Robert Venable. "The Magnitude of Menu Costs: Direct Evidence from a Large U.S. Supermarket Chain," *Quarterly Journal of Economics*, vol. 112 (August 1997), pp. 791–825.

Mankiw, N. Gregory. "Small Menu Costs and Large Business Cycles: A Macroeconomic Model," *Quarterly Journal of Economics*, vol. 100 (May 1985) pp. 529–38.

Means, Gardiner C. "Industrial Prices and their Relative Inflexibility," S. Doc. 13, 74 Cong. 1 Sess. Washington: Government Printing Office, 1935.

Mills, Frederick C. *The Behavior of Prices*, New York: NBER, 1927.

Mussa, Michael. "Sticky Individual Prices and the Dynamics of the General Price Level," *Carnegie-Rochester Conference Series on Public Policy*, vol. 15 (1981), pp. 261–96.

Okun, Arthur M. *Prices and Quantities: A Macroeconomic Analysis*. Washington: The Brookings Institution, 1981.

Rátfai, Attila. "The Size, Frequency and Synchronization of Price Adjustment: Microeconomic Evidence." Manuscript. July 2000.

Rotemberg, Julio J. "Monopolistic Price Adjustment and Aggregate Output," *Review of Economic Studies,* vol. 49 (October 1982), pp. 517–31.

Scitovszky, T. De. "Prices Under Monopoly and Competition," *Journal of Political Economy*, vol. 49 (October 1941), pp. 663–85.

Sheshinski, Eytan, and Yoram Weiss. "Staggered and Synchronized Price Policies under Inflation: The Multiproduct Monopoly Case," *Review of Economic Studies,* vol. 59 (April 1992), pp. 331–59.

——————. "Optimum Pricing Policy under Stochastic Inflation," *Review of Economic Studies,* vol. 50 (July 1983), pp. 513–29.

_____. "Inflation and Costs of Price Adjustment," *Review of Economic Studies,* vol. 44 (June 1977), pp. 287–303.

Slade, Margaret E. "Optimal Pricing with Costly Adjustment: Evidence from Retail Grocery Prices," *Review of Economic Studies*, vol. 65 (January 1998), pp. 87–107.

Stigler, George J. "The Kinky Oligopoly Demand Curve and Rigid Prices," *Journal of Political Economy*, vol. 55 (October 1947), pp. 432–49.

_____, and James K. Kindahl. "Industrial Prices, as Administered by Dr. Means," *American Economic Review*, vol. 63 (September 1973), pp. 717–21.

_____. *The Behavior of Industrial Prices*. New York: National Bureau of Economic Research, 1970.

Stiglitz, Joseph E. "Imperfect Information in the Product Market," in Richard Schmalensee and Robert D. Willig, eds., *Handbook of industrial organization,* vol. 1. Amsterdam: North-Holland, 1989, pp. 771–847.

Sweezy, Paul M. "Demand Under Conditions of Oligopoly," *Quarterly Journal of Economics*, vol. 47 (August 1939), pp. 568–73.

Tucker, Rufus S. "The Reasons for Price Rigidity," *American Economic Review,* vol. 28 (March 1938), pp. 41–54.

Weiss, Yoram. "Inflation and Price Adjustment: A Survey of Findings from Micro Data," in Eytan Sheshinski and Yoram Weiss, eds., *Optimal Pricing, Inflation, and the Cost of Price Adjustment*. Cambridge, Mass: MIT Press, 1993, pp. 3–18.

Willis, Jonathan L. "Estimation of Adjustment Costs in a Model of State-Dependent Pricing," Research Working Paper 00-07. Kansas City: Federal Reserve Bank of Kansas City, December 2000.

Woglom, Geoffrey. "Underemployment Equilibrium with Rational Expectations," *Quarterly Journal of Economics,* vol. 97 (February 1982), pp. 89–107.

Wynne, Mark A. "Sticky Prices: What Is the Evidence?" Federal Reserve Bank of Dallas *Economic Review*, 1995 Q1, pp. 1–12.

Zbaracki, Mark J., Mark Ritson, Daniel Levy, Shantanu Dutta, and Mark Bergen. "The Managerial and Customer Dimensions of the Cost of Price Adjustment: Direct Evidence from Industrial Markets." Manuscript. June 2, 2000.