Sticky Prices: What Is the Evidence?

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After nearly two hundred years of theorizing, we still do not have a very clear understanding of the mechanism whereby changes in the stock of money affect the economy in the short run. This article reviews one of the most popular explanations for why money affects output. This is the idea that prices are "sticky" at nonmarket-clearing levels, thus creating the potential for changes in the money stock to influence the real economy.

One of the most important questions in economics concerns whether and how changes in the stock of money affect the levels of output and employment. More specifically, how can changes in the stock of a nominal quantity, such as the number of dollar bills outstanding, affect the level of a real quantity, such as the total amount of goods and services produced in any given year or the number of workers to be employed in the production of that output? Given that the Federal Reserve's primary means of influencing the pace of economic activity in the United States is through changes in the stock of money, the question is of immediate importance for the conduct of monetary policy.[1] Yet despite the importance of this question, it remains one of the great unsettled issues in economics. After nearly two hundred years of theorizing, we still do not have a very clear understanding of the mechanism whereby changes in the stock of money affect the economy in the short run. This article reviews one of the most popular explanations for why money affects output. This is the idea that prices are "sticky" at nonmarket-clearing levels, thus creating the potential for changes in the money stock to influence the real economy.

The intuition for why changes in the nominal money stock can affect real output in a sticky-price environment is straightforward. Consider a situation in which the economy is in a state of monetary equilibrium. All individuals are holding their desired levels of cash balances, which typically might be expressed in terms of some number of weeks of income. Individuals have arrived at these holdings by trading off their need for cash to facilitate transactions with the cost of holding cash rather than some higher yielding asset. Absent any change in individuals' need to finance transactions or the relative return on cash versus other assets, they will be willing to hold their existing stocks of cash indefinitely.

Suppose now that the monetary authority engineers an increase in the money stock such that each individual's cash holdings increase by exactly 10 percent. Suppose also that the increase is a one-time occurrence, in the sense that it is unanticipated and will not be repeated. One way this might occur would be by means of the metaphorical helicopter drop employed by Milton Friedman in his analyses of the effects on real activity of changes in the stock of money.[2] On average, individuals will now find themselves holding a larger stock of cash than before. Since their previous level of cash holdings was optimal, given their transactions needs and the costs of

holding cash, and since nothing has changed to alter these determinants of their cash holdings, individuals, on average, now hold more than their desired stock of cash. To return to their original level of money holdings, the individuals will increase their spending until their cash balances are back at their original level. However, if all individuals are simultaneously trying to spend down their cash balances, and nothing has happened to make people willing to produce more, the result will be upward pressure on prices. In the long run, equilibrium will be restored when the prices of all goods rise in the same proportion as the initial increase in the money stock.

The more difficult question is what happens during the transition to the new equilibrium. If the prices of all goods and services increased immediately in the same proportion as the money stock, the adjustment would be completed instantaneously and that would be the end of the story. However, if (for whatever reason) some producers are slow to adjust their prices in the face of the increase in nominal demand and choose instead to increase output, we might see an increase in output during the transition period. This failure to adjust prices immediately may come about for a variety of reasons, including, for example, a misinterpretation on the part of some firms of the increased demand for their product or the existence of some menu cost associated with changing prices. Whatever the reason, the failure of prices to adjust rapidly generates the potential for changes in the nominal stock of money to affect real output.

The focus in this article will be on price stickiness or rigidity rather than wage stickiness. Sticky prices or wages are both potential sources of nonneutralities of money, and both may play a role in propagating nominal shocks. However, most economists are skeptical of interpretations that view the failure of nominal weekly or monthly wage payments to fluctuate with business conditions as evidence of stickiness. A better interpretation, many argue, is that periodic wage payments are installment payments on a long-term labor contract (either implicit or explicit) and thus play relatively little allocative role (see, for example, Barro 1977). Incentives other than the promise of higher wages induce workers to work harder during booms; one example might be the implicit promise of being allowed to slack off when things are quieter. Other reasons for being skeptical about the importance of wage rigidity as a propagation mechanism are recent evidence that wages are, in fact, remarkably flexible, and the counterfactual implications of theories with wage stickiness at their core.[3]

The facts about price stickiness

A common criticism of the raw data used to construct the widely used consumer and producer price indexes is that the prices that go into these indexes are list rather than transactions prices. That is, the raw price series do not reflect the prices at which actual transactions take place but rather some irrelevant list price at which relatively few transactions occur. Wynne and Sigalla (1993) review some of the evidence on this problem. The list-transactions problem takes many forms, depending on whether the prices in question are for intermediate or final goods. Firms may be reluctant to report actual transactions prices to the industrial price program that gathers data for the producer price index (PPI) because of fears the data may be used in antitrust litigation or fall into the hands of competitors.[4] Thus, some have argued that price data should be collected from buyers rather than sellers.

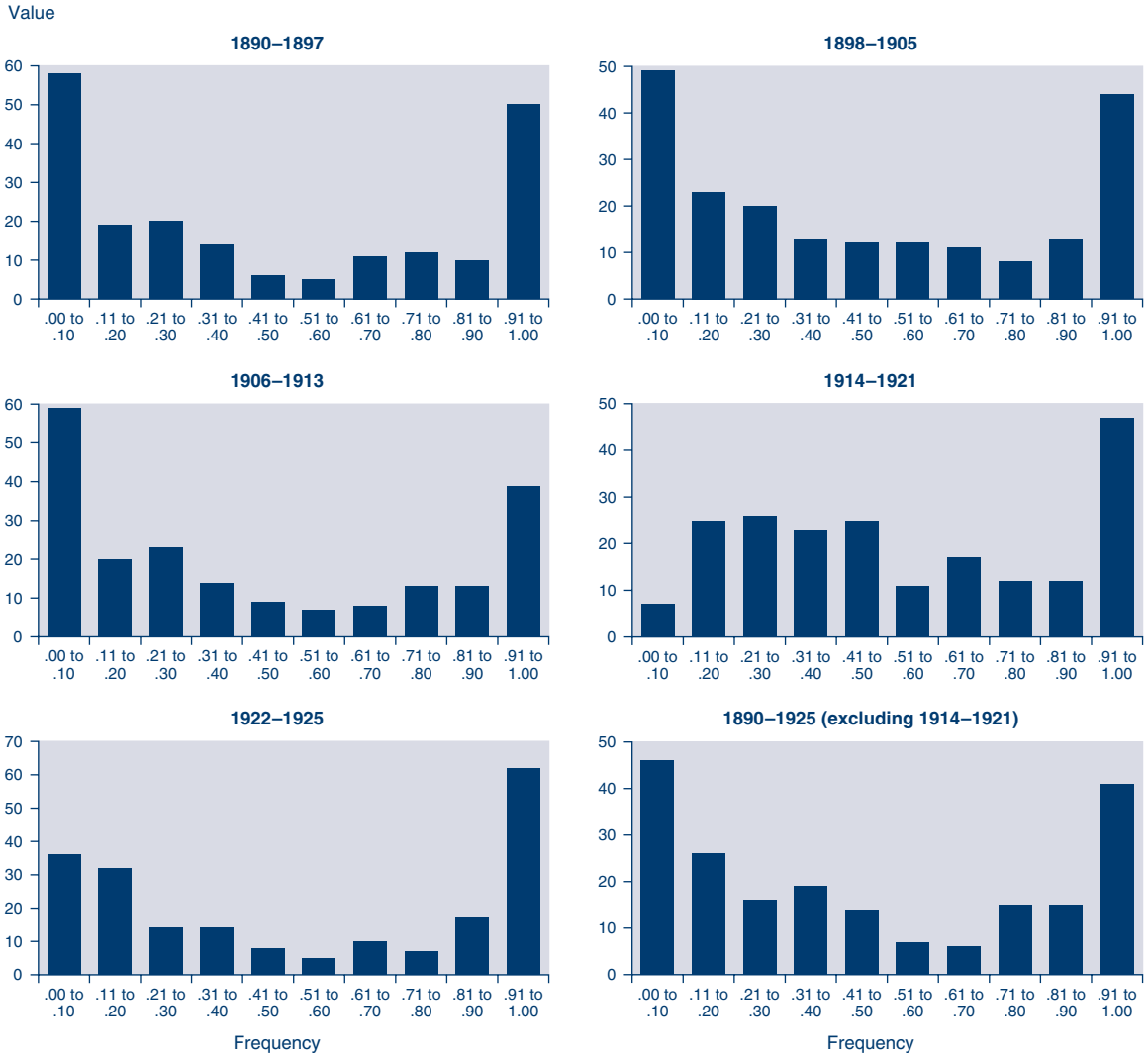
This approach is nearly what is done in the data collection of prices for the consumer price index (CPI). Bureau of Labor Statistics (BLS) reporters visit a variety of stores and collect data on the various products that are to be priced for the CPI. The reporters make adjustments to these products for some but not all discounts. Thus, when pricing automobiles, the BLS collects the car's sticker price; the average discount offered over the recent past; and the prices for standard options, dealer preparation, and delivery to get a measure of car prices that better approximates the prices the average consumer actually pays. One form of discounting that is not taken into account in collecting data for the CPI involves cents-off coupons. The BLS only discounts products for those coupons attached to products for redemption at the time of sale. Clearly, the use of coupons could imply greater price flexibility than is revealed in examinations of the official price statistics, but by how much is uncertain. It is clear, however, that coupon use varies with the state of economic activity.

One other aspect of the official price indexes makes them unsuitable for assessing the overall degree of flexibility of the price of a product. That is, for a variety of reasons, the prices that go onto the official indexes are usually averages of prices obtained from different outlets or firms. Such averages can fluctuate either more or less than their constituent price series, making them unreliable guides to the overall flexibility of prices. Despite these shortcomings of official price statistics, the first study I review (Mills 1927) is based on an analysis of raw BLS data. The review of the literature begins with this study because, despite some serious shortcomings, it

Figure 1

Distribution of 206 Commodities

(*Classified by Frequency of Monthly Price Changes*)



remains one of the most comprehensive assessments of price flexibility, and it also establishes certain results about the frequency of price changes that later studies confirm.

The behavior of wholesale prices, 1890–1924

The earliest study of the frequency of price changes for individual products is probably Mills (1927). Mills studied data collected by the BLS for the purposes of constructing the wholesale price index (WPI) and constructed a measure of the frequency of price changes for an individual commodity by dividing the number of months in which a change in price is recorded by the total number of months for which a price is quoted, less one. Thus, if we have price data for, say, wheat for a ten-year period (120 months), and if in 119 of those months the price changed, then the index would take on a value of one (119/119). Alternatively, if there were no price changes over the ten-year period, the index would take on a value of zero (0/119). Mills constructs this measure for each of the 206 commodities in his data set for six different periods. The resulting class frequencies are plotted in Figure 1. The value of Mills' index is plotted in interval increments on the horizontal axis, while the frequency of each interval value is plotted on the vertical axis. If every product in the sample exhibited a price change in every month of a particular sample period, the rightmost bar on the graph would equal 206 (the number of commodities in the sample), with zeros elsewhere. Likewise, if no commodity exhibited a price change during any month of the sample, all the mass of the distribu-

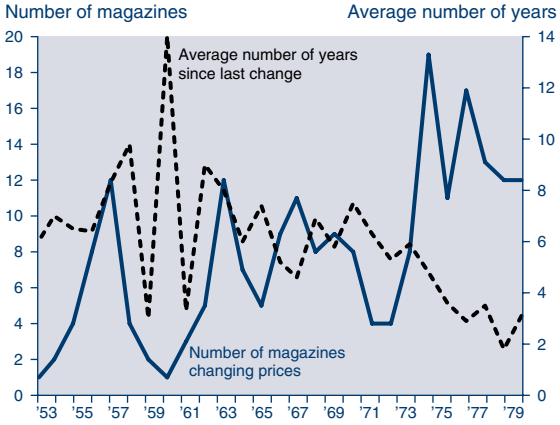
tion would be concentrated in the leftmost bar on the graph, with zeros everywhere else.

The most striking feature of these graphs is the uniformity of the U-shaped distribution of price changes. That is, there are a lot of products for which prices change relatively infrequently, and there are a lot of products for which prices change frequently. Perhaps not surprisingly, the only products with an index value of one in all the sample periods are farm products (hogs and sheep). For a lot of other products, prices change almost every month (that is, index values for these products are close to one). Another point to note about Figure 1 is how the distribution of price changes shifted during the period including the years of World War I (1914–21).

While Mills' results are of great interest, there are at least two important problems with the data he uses. First, despite his claims that the data are not averages, it is not clear that this is the case. Examination of Table 1 of the appendix to his book reveals many commodities for which it seems likely that the data used are, in fact, averages over several price quotations. The second problem is that data collected for the BLS's industrial price program have often been criticized as reflecting list prices rather than transactions prices. Both the Stigler report (NBER 1961) and the Ruggles report (U.S. Executive Office of the President: Council on Wage and Price Stability 1977) make this point forcefully. Finally, some of the criticisms of later studies that will be noted below are probably also applicable to Mills' study. Specifically, adjustment for quality change was essentially nonexistent in the early years of the BLS, which raises the possibility that some of the price stickiness found by Mills may have been accompanied by quality deteriorations.

The newsstand prices of magazines. Cecchetti's (1986) study of the newsstand prices of magazines is probably the most widely cited and influential piece of evidence that prices are sticky. Cecchetti looked at the prices of thirty-eight magazines over the period 1953 to 1979. One virtue of this data set is that the prices are known to be transactions prices rather that just list prices. The use of discounts for newsstand magazine purchases is rare.[5] The main stylized facts about price stickiness presented by Cecchetti are shown in Figure 2. Two points are noteworthy. First, the prices of the magazines in the sample change relatively infrequently. At most, only half the magazines in the sample change price in any one year (the peak year being 1974). Second, note the increased frequency of price changes and decline in the average number of years since the last price change as inflation accelerated in the late 1970s.

Figure 2
Magazine Price Changes, 1953–79



Cecchetti also observes that the average decline in real price between nominal price changes increased dramatically during the 1970s. He interprets this as evidence of "incredible" price stickiness, which can only be explained by high fixed costs of price changes.

Nevertheless, the Cecchetti study raises numerous questions that undermine the broader inferences that can be drawn from it. For a start, one has to note the small size of the sample of prices studied. Cecchetti himself concedes that a mere one-third of all magazine sales in his sample are single-copy (newsstand) sales. Most people buy magazines through subscriptions. What do we know about the prices of magazines purchased through subscriptions? Obviously, when one enters a subscription for a magazine, one obtains (typically) a year's worth of issues of the magazine at some fixed average price over the period of the subscription. Yet frequently magazines offer various discounts for subscribing, either in the form of "professional courtesy" discounts or reduced rates for longer subscription periods.[6]

A potentially more serious shortcoming of the Cecchetti study is the absence of any control for quality. In view of Blinder's recent survey findings (discussed below), one wonders whether magazine publishers effectively raise the price of their magazines by changing such aspects of product quality as the publication's size, the ratio of advertising to nonadvertising pages, or the number of color versus black-and-white pages. Are stockouts at newsstands more common as the real price of magazines declines with rising inflation?[7]

This is essentially the point Koelln and Rush (1993) make. Echoing an earlier argument by Carlton (1983), Koelln and Rush note that magazine publishers may alter some aspect of their

product's quality to adjust the effective price during the period between nominal price changes. Koelln and Rush specifically identify the possibility of altering the number of pages of text as a potential means of offsetting declines in real price during the interval between price changes. Koelln and Rush look at "net page" and price data over the 1950–89 period for seven magazines (five of which were included in Cecchetti's sample). The authors note that the magazine with the most inflexible size over this period also had by far the largest number of nominal price changes. They interpret this observation as supporting the hypothesis that variation in quality (magazine size, in this case) is a potentially important alternative to variation in price. Koelln and Rush also find a statistically significant (positive) relationship between the number of text pages in a magazine and the real price of the magazine. That is, as inflation erodes the real price of a magazine during the interval between nominal price changes, the number of text pages tends to decline. Koelln and Rush conclude that the price rigidity Cecchetti's study uncovered is significantly overstated.[8]

A third potential objection to Cecchetti's findings has to do with potential sample selection bias. Since the primary objective of Cecchetti's study was to investigate the determinants of the frequency of nominal prices changes, he explicitly chose to study prices that were not determined in auction markets but rather were known a priori to remain fixed for relatively long periods. Thus, Cecchetti (1986, 256) notes that the newsstand prices of magazines "exhibit the *desired* property of discrete and infrequent adjustment" (emphasis added). This, of course, raises the question of how representative the sample of prices Cecchetti examined is of all prices in the economy.

The prices of industrial commodities. Carlton (1986) revisits the data collected by Stigler and Kindahl (1970) in their monumental study of the behavior of industrial prices. Part of the objective of the Stigler–Kindahl study is to collect accurate data on transactions rather than list prices for industrial commodities. As noted above, it has long been suspected that the aggregate price indexes the BLS publishes are based on list rather than transactions prices. To get around the list–transactions price problem, Stigler and Kindahl collect data from buyers rather than sellers, the presumption being that buyers have less of an incentive to report list rather than transactions prices than do sellers.[9] Stigler and Kindahl also make corrections for discounting and for changes in product specification. Their sample period is January 1, 1957, through December 31, 1966.

The commodities for which price data were collected were intermediate products used in manufacturing and were preselected to satisfy two important criteria. First, Stigler and Kindahl focus on the prices of those commodities "for which the charge of inflexible prices has been heard most frequently" (Stigler and Kindahl 1970, 23). The reason for this focus is the authors' interest in testing certain theories of administered prices. Thus, the prices they collected were preselected to exhibit some degree of price rigidity. Stigler and Kindahl's second criterion for price data is the absence of rapid quality change in the products, which helps avoid the difficulty of disentangling quality from price changes. Stigler and Kindahl note that "the problem of measuring change in the quality of products is *the* major unresolved task of all price collection" (Stigler and Kindahl 1970, 23), and this remains as true today as it was when they wrote their book twenty-five years ago.

Carlton concludes on the basis of his analysis of the Stigler–Kindahl data that there is significant price rigidity in many industries. For industries like steel, chemicals, and cement, Carlton finds that prices are, on average, unchanged for more than one year. Furthermore, there is a positive correlation between price rigidity and the size of price changes. In other words, the longer prices are rigid, the greater the eventual price change. But just as there are many examples of products and transactions for which prices remain fixed for long periods, so too are there many instances of small price changes (meaning a change of less than 1 percent). This observation suggests that either the costs of changing price are very small or that the costs of being at the wrong price are very high. With either explanation, the observation of long periods of price rigidity is difficult to explain. Interestingly, Carlton finds a negative relationship between price rigidity and the length of association between buyers and sellers, making an installment payment interpretation of the observed price rigidity implausible. Finally, Carlton finds no evidence that prices downward are more rigid than upward.

Of all the studies of price flexibility, the Carlton–Stigler–Kindahl study is the most comprehensive in that it looks at the prices of the largest number of products. Nevertheless, the findings need to be interpreted with caution. As noted, Stigler and Kindahl's preselection criteria make the prices of the products they study unrepresentative of prices of all products. Another point to note about Carlton's results is that during the period covered by his data, WPI inflation averaged only 1.1 percent a year.[10] It

would be interesting to have a study as comprehensive as the Stigler–Kindahl exercise repeated for a period of higher inflation.

Prices in retail catalogs. The most recent study documenting the behavior of transactions prices is Kashyap (1991). Kashyap looks at the behavior of the transactions prices of twelve retail goods over the period 1953 to 1987 from the retail catalogs of three firms: L. L. Bean, Inc.; The Orvis Company, Inc.; and Recreational Equipment, Inc. (REI). Kashyap sidesteps the problem of dealing with quality change by looking only at the prices of products that are homogeneous over long periods. The specific products are a pair of hunting boots, pair of moccasins, chamois shirt, blanket, and duffel bag from L. L. Bean; a bamboo fly rod, fly, poplin fishing hat, pair of binoculars, chamois shirt, and blanket from Orvis; and a chamois shirt from REI. All three of the companies in the study fix their prices for six-month intervals, implying that there are at most two price changes that can be observed each year. Kashyap collected data by copying prices from old catalogs. Prices are list prices for one unit of an item: no account is taken of discounts for bulk purchases that each company has occasionally offered. Kashyap provides no data on the size of these discounts (he simply asserts that they are "very slight") or on their frequency. He also ignores "sales prices which may have been available for very short periods" (Kashyap 1991, 6–7).[11] One key advantage of Kashyap's data over that analyzed by Cecchetti is that the goods are high-volume goods for which even small changes in price produce nontrivial changes in revenue. By contrast, subscriptions and advertising are far more important sources of revenue for magazine publishers than are newsstand sales.

Kashyap draws three main conclusions from his empirical analysis:

1. Nominal prices are typically fixed for periods longer than one year, and the time between price changes is very irregular.
2. Prices change more often during periods of high inflation but not by larger amounts than during periods of low inflation.
3. When prices do change, the sizes of the changes are widely dispersed.

Kashyap notes that his data strongly contradict simple versions of (*S*,*s*) pricing models. For example, the simple versions of these models that assume that price changes should always be in one direction are rejected by the frequency of price reductions. Two-sided (*S*,*s*) models that keep the size of the change in each direction fixed are rejected by the finding that the size of price changes, when they do occur, is highly variable. Furthermore, the absence of any correlation between the average size of price changes and the (core) rate of inflation poses serious problems for simple tractable versions of (*S*,*s*) models.[12]

Kashyap addresses the possibility that catalog prices might be suspected of being artificially sticky by citing Rees' (1961) finding that catalog prices tend to closely track prices in retail outlets. However, Rees (1961, 138) explicitly notes the following:

> There is a problem in the determination of the period during which catalog prices are in effect. Special sales and in some cases price increases may be announced shortly after catalogs are issued, and we have no collection of such announcements. Changes in the proportion of all sales made through special sales catalogs and changes in the difference between general catalog and sales catalog prices could introduce bias into our indexes.

Furthermore, the sample of products Rees examined was in no sense random. Specifically, the sample of goods Rees looked at was a judgment sample of nondurable goods, although he made a deliberate effort to include both goods that were little influenced by innovation or technical change over the sample period and goods that were subject to significant quality changes. It would be interesting to know whether today, with the growth of catalog shopping, Rees' results still hold up. The problem remains that the products Rees looked at are not in any sense representative of the wide range of products consumers typically buy. As for the possibility of changes in delivery lags as prices become more out of line, Kashyap asserts that since most of the products in his sample are popular and have been carried by the different retailers for long periods, the retailers have a good sense of what demand for the products looks like, thus rendering stockouts less common.

Evidence from interviews. Blinder (1991) proposed interviewing actual price setters in business firms to gain insights into the factors that underlie decisions to change prices. The primary objective of Blinder's study was to find evidence that would allow us to discriminate between competing theories of price stickiness, rather than document how frequently the firms in his sample changed their prices. Blinder notes that testing the notion that prices are sticky is probably impossible, as

price stickiness usually means nothing more than that prices change less rapidly than their unobservable Walrasian market-clearing values. While Blinder does not report raw data on price changes for the firms in his survey, he does report two findings relevant to this survey of the literature. First, most firms in Blinder's sample (55 percent) claim to change their prices no more than once a year, with only 10 percent of companies changing price as often as once a month. Blinder interprets this observation as evidence of significant price rigidity. Of even more importance in the interpretation of this result is the finding that three-fourths of the sample firms, when asked to rank the underlying factors in their decision not to change prices when demand is high or low, said they changed some other aspect or quality of their product instead. Specifically, 76 percent of the firms in the sample accepted the notion that delivery lags could be lengthened or quality of auxiliary service reduced as alternatives to raising prices when demand is tight.[13] These findings echo Carlton's earlier hypothesis that price may be only one of several mechanisms firms use to allocate output and raise serious questions about the interpretation of observed nominal rigidities.

Assessment of the evidence

In assessing the evidence on price stickiness, one cannot help but be struck by the scant documentation of how frequently prices actually change. I have been able to find only three studies (Cecchetti, Carlton, and Kashyap) that make a serious attempt to document price stickiness in the postwar United States. Although this review of the literature includes the earlier work by Mills, his is probably the most suspect study cited.

Another striking aspect of price stickiness documentation is the very small fraction of gross domestic product (GDP) it covers. It is remarkable that Cecchetti's results on the newsstand prices of magazines should receive such widespread attention in view of the trivial fraction of GDP those sales represent.[14] The most comprehensive of the modern studies is Carlton (1986), but the products in that study were all intermediate rather than final goods. However, Ball and Mankiw (1994) argue that when it comes to assessing the importance of sticky prices as an explanation for monetary neutrality, it is necessary only that those goods purchased with money (by which they seem to mean currency) exhibit stickiness, since the prices of goods bought with credit do not directly affect the demand for money. Ball and Mankiw note that goods purchased with currency are typically small retail items (such as newspapers and haircuts) and that experience suggests these are the goods for which prices are most sticky.

The third observation about the evidence is that, in many cases, the sample of prices studied is biased toward the inclusion of prices that were known a priori to be relatively inflexible. Thus, Cecchetti was primarily interested in estimating models of price adjustment rather than documenting facts about price changes when he compiled his data on the newsstand prices of magazines. Likewise, Stigler and Kindahl were primarily interested in testing theories of administered pricing (and thus biased their sample toward products for which administered [or rigid] prices were thought to be particularly prevalent) when they assembled the price data later analyzed by Carlton (1986). Finally, despite Kashyap's citing earlier work by Rees (1961) that found that prices in catalogs tend to mimic prices at retail outlets remarkably well, the fact remains that there is potentially a lot more flexibility in catalog prices than Kashyap documented.[15]

Another way in which the prices documented as being relatively sticky fail to represent all products is the homogeneity of the documented products over time. Because of the difficulty of separating price changes due to changes in the quality of a product from pure price changes, most of the studies focus only on products for which this is not likely to be a problem. Thus, the Stigler–Kindahl data set contains a lot of low-tech products like steel and lumber, and Kashyap focuses on consumer goods like shirts and shoes that exhibit little or no quality changes over time. But the fact remains that many high-tech products have remarkably flexible prices. Would anyone seriously suggest that the appropriate (quality-adjusted) prices of personal computers stay fixed for very long? Indeed, durable goods in general tend to have very flexible prices, as witnessed by the frequent sales for electronic equipment. Returning to the more basic end of the consumer products spectrum, food prices (especially those of fresh fruit and vegetables) fluctuate in line with market conditions.[16] As for services, barbers may not change the price of a haircut very often, but the same cannot be said for airfares.

Carlton (1983) raised an important point concerning the interpretation of findings that the prices of some or many products are sticky or inflexible. He notes that the observation that the price of a product is inflexible for long periods is meaningless if the product changes over time. The specific example he considered was one in which delivery lags could be lengthened in lieu of raising price when demand is tight. As evidence for the potential importance of this mechanism for

allocating output, Table 1 shows the standard deviations of price and delivery lags in selected industries. In each case, delivery lags are more variable than price, in some cases considerably so. But Carlton's point applies more generally and to aspects of the product other than time to delivery. Thus, to note that the price of a magazine stays fixed for, say, a year is not very interesting if the magazine changes its ratio of advertising to text during the year. Koelln and Rush (1993) note such a possibility in connection with Cecchetti's study of magazine prices. Similarly, to note that the price of a piece of apparel stays fixed for a long period is not very informative if instead the fabric content of the item changes. Indeed, just such a phenomenon occurred during WWII when price controls held the nominal price of various consumer goods constant. Manufacturers skirted these price controls and effectively raised prices by lowering the quality of the goods.[17] Blinder's interview study lends further credence to this possibility with the finding that most firms in his sample accepted that changes in delivery lags or other aspects of the product were a common alternative to nominal price increases.

While these studies document many cases in which prices stay fixed for long periods, they also find many instances in which prices are very flexible, changing frequently and often by small amounts. The earliest evidence on this is the U-shaped distributions plotted by Mills for wholesale prices in the pre-World War II period. Carlton also finds many instances of frequent and small price changes in the Stigler–Kindahl data set, and Blinder observes that about 10 percent of the firms in his sample change their prices as often as once a month.

Finally, there is evidence that price changes are more frequent during periods of high inflation than during periods of low inflation. This is one of the main findings of Cecchetti's study, and is also reported by Kashyap. Additional evidence on the frequency of price adjustment during periods of high inflation in Israel is presented in Sheshinski, Tishler, and Weiss (1981); Lach and Tsiddon (1992); and Eden (1994). The importance of this result is that it demonstrates that firms' pricing policies are not unresponsive to changes in the environment. Thus, a monetary policy aimed at stabilizing output and predicated on the notion that price changes occur at fixed intervals would be based on a false assumption.

Blinder (1991, 1990) writes that attempts to test the notion that prices are sticky are hindered by the ambiguity of the terms "sticky" and "flexible." To say that prices are sticky often means no more than that they are less flexible or adjust less rapidly than Walrasian market-clearing prices. However, this is a rather amorphous benchmark, since Walrasian market-clearing prices are themselves unobservable. Of course, the sensible thing to do then is to test the other predictions of the theory. Do models with sticky prices do a better job at explaining business cycles that do models with perfect price flexibility?

Ball and Mankiw (1994, 35–36) note that "A scientific theory should be judged not only by the intrinsic appeal of its assumptions, but also by its ability to explain observed facts—especially ones that it was not explicitly designed to explain." In view of the scant evidence on price rigidity and the inherent difficulties in augmenting such evidence as there is, perhaps the best way to assess the quantitative importance of price rigidities for understanding fluctuations in economic activity is to compare the performance of models with price rigidities with that of models with fully flexible prices to see which does better in explaining the stylized facts of the business cycle.

Cho and Cooley (1990) explore the quantitative implications of nominal price contracts (or sticky prices) for the transmission and propagation of shocks in a standard business-cycle model. The model they study is a variant of the one-sector, neoclassical growth model augmented with a cash-in-advance constraint. They study the effects of nominal price contracts that vary in length from one to eight periods on the propagation of both monetary and technology shocks, with prices set each period on the basis of expected marginal costs. Cho and Cooley show that only a small amount of price stickiness is needed in their model to generate output volatility of the same magnitude as observed in the U.S. data. Monetary shocks propagated by nominal

Table 1
Price and Delivery Lag Fluctuations

SIC code	Industry	Standard deviation of log of price	Standard deviation of log of delivery lag	Median delivery lag in months
22	Textile mill products	.06	.17	1.26
26	Paper and allied products	.05	.08	.46
331	Steel	.03	.25	1.95
34	Fabricated metals	.03	.18	3.06
35	Nonelectrical machinery	.04	.25	3.63
36	Electrical machinery	.05	.10	3.86

SOURCE: Carlton (1983, Table 1).

price stickiness for a small number of products thus may be an important element in furthering our understanding of the business cycle under certain price-setting rules. However, nominal shocks by themselves propagated by nominal contracts are not a viable alternative to technology shocks as a source of business cycles: while monetary shocks propagated by nominal contracts can generate output volatility of the right order of magnitude, other features of such a model are inconsistent with the facts of U.S. business cycles.

The consequences of price stickiness in a general equilibrium model have also been investigated by Ohanian and Stockman (1994a, b), who examine an economy in which some prices are set in advance and some are free to change instantaneously. Prices in the sticky-price sector are assumed to be set at their expected market-clearing level. Ohanian and Stockman show that only a small degree of price stickiness may be sufficient to generate big effects from nominal shocks. However, as the model studied by Ohanian and Stockman abstracts from capital accumulation, it is not clear how robust their results are. In particular, the inclusion of capital accumulation would introduce an additional margin along which substitution could occur in response to exogenous disturbances, necessitating the existence of a larger sticky price sector to generate plausible liquidity effects. Just how much larger is an open question.

A key shortcoming of the Cho–Cooley and Ohanian–Stockman analyses is that they graft ad hoc price-setting rules onto otherwise standard general equilibrium models. Beaudry and Devereux (1993) overcome this problem by examining a model in which intermediate goods-producing firms find it optimal to preset prices, and do so in a way that maximizes expected profits.[18] Beaudry and Devereux find that their model is able to match key features of the data reasonably well, in the sense that the impulse responses computed for the model for monetary and technology shocks are similar to those generated by U.S. data. In particular, the endogenously sticky prices generate a quantitatively important propagation mechanism for nominal shocks.

In contrast to the studies just mentioned, the results of Kydland (1991) suggest that sticky prices may have little role to play in explaining output fluctuations. Kydland finds that an equilibrium business-cycle model with price flexibility can account for about two-thirds of the fluctuations in output and the price level as a response to technology shocks alone. All movements in the price level come about as a result of real shocks; there are no fluctuations in the money stock. Since prices in the real world are more volatile than prices in the model, sticky prices may explain little about the remaining one-third of volatility that cannot stem from technology shocks alone.

Conclusions

The notion that nominal price rigidities play an important role in the transmission and propagation of nominal shocks to the real economy is one of the oldest ideas in economics, dating back at least to the work of David Hume in the eighteenth century. In this article, I make two points about this literature. First, despite its widespread acceptance among economists, there is remarkably little evidence to support the notion that prices are sticky. The only way to determine how frequently prices change is to collect and examine data on the prices paid in individual product transactions. To date, I have been able to uncover only three studies that document the frequency of price adjustment in the U.S. economy. Given the importance of price stickiness to much of contemporary macroeconomic thinking, one would have thought that there would be a lot more evidence to support this assumption.

My second major point in this article is that the evidence, in many cases, must be interpreted with caution. If buyers and sellers are able to alter product characteristics other than price to arrive at market-clearing outcomes, it is not clear that the observation that posted prices are sticky implies a role for interventionist policy. If private markets are achieving efficient outcomes without the aid of the government, the government would do best by doing nothing. Carlton (1989) concludes his survey of how markets clear with this comment:

> The importance of price diminishes once one recognizes that price alone may not be clearing markets and, instead, that price in conjunction with other mechanisms, such as a seller's knowledge of a buyer's needs, is performing that function. Indeed, if price is not the sole mechanism used to allocate goods, it becomes less interesting to observe whether price remains rigid. Although a rigid price does imply inefficiency under any of the simple models in which price alone is the exclusive mechanism used to achieve efficient resource allocation, a rigid price does not imply inefficiency in a world in which price is but one of the many methods firms are using to allocate goods to customers.

Despite the caveats about evidence of price stickiness, it may well be that only a small degree of genuine price stickiness is needed for nominal or monetary shocks to generate a quantitatively significant role as a source of business cycles. The recent results of Cho and Cooley and Ohanian and Stockman are particularly suggestive in this regard. Can models that assume nominal rigidities are an optimal response to some aspect of the economic environment reproduce the key facts of the U.S. business cycle? The question remains open.

Even if prices are fully flexible, this does not imply that monetary policy has no role in affecting the level of output. Sticky prices are only one mechanism whereby changes in the stock of nominal money can affect the real economy. Recent literature has sought to explain the real effects of monetary policy by invoking the notion of market incompleteness. Thus, the outcome of the debate on whether sticky prices matter for understanding business cycles may have little to do with how effectively the Federal Reserve can contribute to smoothing the business cycle.

Notes

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[1] The Fed also influences the level of economic activity through changes in reserve requirements. Such changes affect the real opportunities for borrowing and lending and are thus considered more likely to have an influence on real economic activity.

[2] See, for example, chapter 2 of Friedman (1992).

[3] See, for example, Gordon (1990), who notes that only price stickiness is needed to generate cycles in real output, given a path of nominal aggregate demand. Gordon adds that price flexibility is fully consistent with nominal wage rigidity as long as profits are sufficiently flexible.

[4] Foss (1993) discusses how the threat of antitrust litigation discourages accurate reporting of transactions prices by firms.

[5] Although not anymore: it is now quite common for bookstores to offer discounts of 10 percent on the purchase of books or magazines when the customer joins the store's "frequent buyer" program.

[6] For example, the average price per issue of *The Economist* is lower for a two-year subscription than for a one-year subscription.

[7] It is worth noting that insofar as changes in the real characteristics of a product result from nominal shocks, this supports the notion that money does have an effect on real output, even though prices, when properly measured, may be completely flexible.

[8] Koelln and Rush also note that advertising further complicates the interpretation of sticky magazine prices. Insofar as revenue from advertising is more important to the magazine publisher than revenue from newsstand sales, the appropriate interpretation of observed sticky cover prices is not clear. The authors note that prior to the inclusion of advertising in *Reader's Digest* in 1956, the number of pages in each issue had declined in several steps from 180 pages in January 1950 to 168 pages in January 1955. To limit the complications introduced by advertising, Koelln and Rush focus on magazines for which they think advertising is relatively unimportant.

[9] Stigler and Kindahl do, in fact, find that their measures of transactions prices were substantially more flexible than the BLS price indexes.

[10] CPI inflation averaged 1.8 percent a year over the same period.

[11] Kashyap also ignores any postage and handling charges. He claims that this factor is less serious than it might seem, as all Bean prices include these charges, and the Bean prices can be used to establish all the results reported in the study.

[12] Simple menu-cost arguments cannot explain the infrequency of price changes in catalogs. The menu cost in such a case is just the cost of printing the catalog, and this cost is the same whether none or all of the prices change.

[13] Again, the question relevant to an understanding of potential transmission or propagation mechanisms for monetary policy is whether "tight" demand can result from a nominal shock. See note 8.

[14] The closest way to assess the relative importance of magazine sales in GDP is to look at the ratio of consumer spending in the category "Magazines, newspapers, and sheet music" to GDP. Over the period covered by Cecchetti's study, spending in this category amounted to less than one-half of 1 percent of GDP (0.41 percent to be precise)!

[15] It is also worth asking how representative catalog sales are of all retail sales in terms of the demographics of the buyers. One suspects that most catalog sales covered in Kashyap's study were to relatively prosperous consumers with relatively high opportunity costs of time.

[16] Levi, Bergen, and Dutta (1994) look at the price of selected brands of orange juice in a retail outlet and find that the prices of some brands change, on average, every two weeks.

[17] For a discussion of quality deterioration in connection with price controls during wartime, see Rockoff (1984).

[18] Ireland (1994) also shows that in an economy in which some firms must set prices one period in advance, the optimal pricing rule does not equate the preset price

with expected marginal costs, except when shocks are serially uncorrelated.

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