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# Implications of Structural Changes in the U.S. Economy for Pricing Behavior and Inflation Dynamics

*Jonathan L. Willis*

Some key features of the behavior of inflation in the United States appear to have changed in the past 20 years, with potentially important implications for forecasters and policymakers. A number of recent studies have provided strong evidence of a decline in the quarter-to-quarter or year-to-year variability of inflation. There is also evidence, albeit less conclusive, of a reduction in inflation persistence, which is a measure of how long it takes inflation to return to baseline after an unexpected change. Such shifts in the behavior or dynamics of inflation would necessitate changes in the economic relationships used by policymakers and economists to assess current conditions, forecast key economic indicators, and determine the implications of policy changes for future economic activity.

Because inflation is ultimately a monetary phenomenon, the shift in dynamics might be due to a systematic change in the conduct of monetary policy since the late 1970s or early 1980s. Examinations of monetary policy, however, have yet to provide convincing evidence of such a shift. While some evidence suggests that the behavior of policy changed dramatically in the late 1970s or early 1980s, several empirical studies find that it has been stable.<sup>1</sup>

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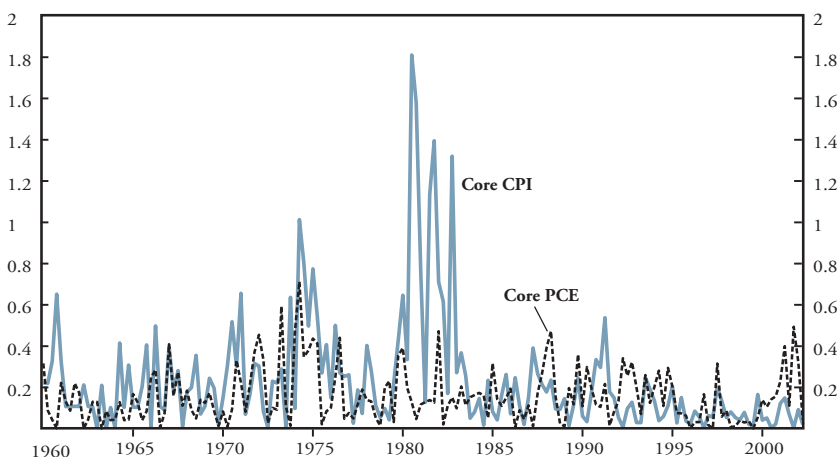
The shift in U.S. inflation dynamics might also reflect structural changes in the economy. Structural changes in the economy can affect the price-setting behavior of individual firms, which, when aggregated into the overall price index, could lead to changes in inflation dynamics. According to basic economic theory, a firm determines its desired price as a markup over the marginal cost of inputs to production. Structural changes in the economy that affect the business cycle behavior of input costs or the markups charged by firms can alter the behavior of firms' prices. Such changes may include an increase in global competition or technological advances. Other changes, such as the increased use of temporary workers, could affect the behavior of marginal costs by providing firms with more flexibility in their use of inputs and, in turn, with less volatile input costs. Additionally, firms may sometimes allow their actual prices to differ from their desired levels because of the costs involved in adjusting prices. Recent advances in information technology, however, may have reduced these adjustment costs, making it cost effective for firms to update prices more frequently. The important question is whether these structural changes have led to systematic differences in aggregate inflation dynamics over the business cycle.

This article will examine how structural changes in the economy over the past two decades may have affected the price-setting behavior of firms and, in turn, the behavior of aggregate inflation. The first section presents empirical evidence on changes in inflation dynamics. The second section begins the analysis of structural changes at the firm level, focusing on factors affecting the behavior of wages, the cost of capital, and materials costs. The third section focuses on the markup of price over marginal cost, discussing the impact of increases in global competition on pricing behavior. The fourth section explores how information technology may affect the costs associated with changing prices and, therefore, the frequency of price adjustment. Following the discussion of how individual firms set their prices, the fifth section examines how these changes in firm pricing behavior may translate into decreases in the persistence and volatility of aggregate inflation. The article concludes that structural changes in the economy over the past 20 years have likely contributed to a decrease in the persistence and volatility of inflation.

Chart 1

## ABSOLUTE CHANGE IN QUARTERLY INFLATION

Percentage points



Source: Bureau of Labor Statistics and Bureau of Economic Analysis

## I. INFLATION DYNAMICS

Although inflation dynamics may be characterized by a wide variety of measures, much recent research has focused on two statistical features: volatility, or how much inflation varies from quarter to quarter or year to year; and persistence, or the speed with which inflation returns to baseline after a shock. In statistical terms, these concepts are distinct, but not entirely so. Other things equal, less persistence leads to less variability. Lower persistence is associated with faster but smaller swings in inflation over time that, in statistical terms, reduce the overall variability of inflation.

By both measures, the dynamics of core consumer price inflation have shifted significantly in the past 20 years. The volatility of inflation—measured here by the average absolute change in quarterly inflation—has clearly fallen (Chart 1). The volatility of core CPI inflation declined from 0.32 percentage point over 1960–82 to 0.12 percentage point over 1983–2002 (Table 1). The variability of core inflation in the personal consumption expenditures (PCE) price index posted a similar decline. Empirical studies have also found that the variance of inflation was lower over the past two decades than in the 1960s and 1970s (Cogley and

*Table 1*  
**AVERAGE ABSOLUTE CHANGE IN QUARTERLY  
 INFLATION**

	<u>Core CPI</u>	<u>Core PCE</u>
1960-82	.32	.16
1960-72	.20	.14
1973-82	.49	.20
1983-2001	.12	.15

Note: Measurements are expressed in terms of percentage points.

Sources: Bureau of Labor Statistics, Bureau of Economic Analysis, and author's calculations.

Sargent; Stock and Watson).<sup>2</sup> Admittedly, abstracting from the high variability of the 1970s and early 1980s makes the evidence on inflation volatility more mixed. When the past 20 years are compared with the 1960s, inflation volatility has declined as measured by the core CPI but not by the core PCE price index (Table 1).

The persistence of inflation also appears to have fallen in the past 20 years. According to formal statistical tests that treat the date of the change as unknown and seek to identify it, the decline in persistence occurred in the early 1990s (Table 2).<sup>3</sup> In the case of the core CPI, persistence declined from a value of 0.90 for 1960–1990 to 0.77 for 1990–2002. For the conventional measure of persistence used in this article, an estimate near 1 would correspond to extremely high persistence, while an estimate of 0 would represent no persistence. An even stronger decline in persistence was found using the core PCE price index, where the estimated value fell from 0.89 for 1960–1992 to 0.66 for 1992–2002.<sup>4</sup>

While statistical studies have shown formal statistical tests to be effective at identifying whether persistence has changed, the tests have more difficulty in precisely identifying the timing of the change. Accordingly, the changes in persistence may have occurred considerably before or after the dates identified by the tests. Using a different methodology, Cogley and Sargent found that inflation persistence peaked in 1979–80 and has since declined. Stock, however, used yet another approach that indicated that the persistence of inflation was essentially unchanged over time.<sup>5</sup>

Table 2

PERSISTENCE OF INFLATION:  
ESTIMATES OF BREAKS IN PERSISTENCE LEVEL

	<i>Date of Break in Persistence</i>	<i>Persistence (before break)</i>	<i>Persistence (after break)</i>
Core CPI	1990:Q3	.90 (.08)	.77 (.09)
Core PCE	1992:Q1	.89 (.03)	.66 (.07)

Note: Standard errors reported in parentheses.

Sources: Bureau of Labor Statistics, Bureau of Economic Analysis, and author's calculations.

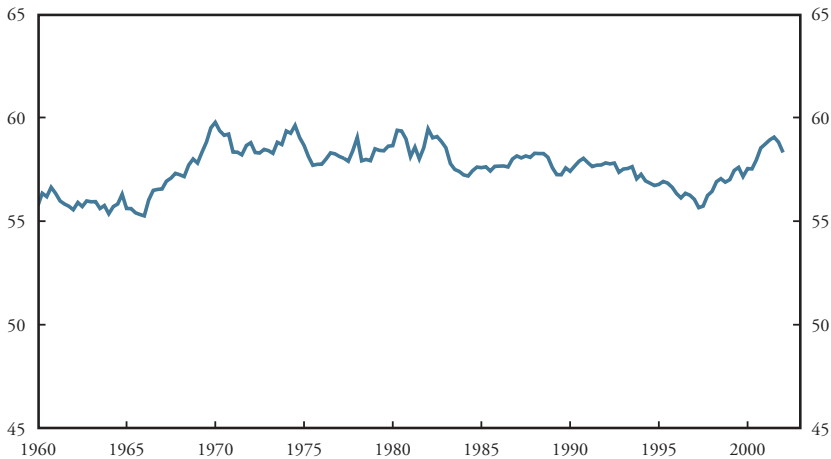
## II. INPUT COSTS

The decline in the volatility and persistence of inflation over the last 20 years could be a result of changes in the pricing behavior of firms. To build on economists' theories of price setting, Blinder, Canetti, Lebow, and Rudd surveyed 200 firms, selected to be a representative sample of the U.S. economy, on the relevant factors involved in their price-setting decisions.<sup>6</sup> To learn how frequently these decisions are made, the authors asked firms, "How often do the prices of your most important products change in a typical year?" Nearly half of all firms responded that prices are adjusted at most once a year. When asked why price adjustment does not occur more frequently, one of the top responses was, "Our costs do not change more often." This response highlights the importance of input costs in the pricing decision.

Given the markup of price over the cost of production, changes in input costs may lead to changes in output prices in two basic ways. In the simplest case, a firm may respond to a cost increase by passing the increase along directly to the output price. Perhaps more realistically, a firm may mitigate the input cost increase by substituting to an alternative input and then passing the smaller cost increase on to its output price. The basic inputs to production are labor, capital, and materials. This section describes several recent structural changes in the economy affecting the behavior of the costs of these inputs.

*Chart 2*  
**TOTAL LABOR COMPENSATION**

Percentage of GDP



Source: Bureau of Economic Analysis

*Labor*

Among all inputs to production, labor constitutes the largest portion of total costs for most goods and services produced. For the economy as a whole, labor costs, measured as total compensation, account for approximately 60 percent of total value-added costs in the economy.<sup>7</sup> Labor's share of total costs has remained relatively stable over the past 40 years (Chart 2).

Over this same period, the composition of labor costs has changed dramatically. Broadly defined, labor costs fall into two categories: wages and salaries paid to workers and benefits. From 1970 through 1993, wages and salaries paid to workers, expressed as a percentage of GDP, decreased (Chart 3). Over the same period, benefits paid to workers increased from 6 percent of GDP to 11 percent of GDP (Chart 3). In the mid-1990s, these trends reversed, as the fraction of labor costs associated with wages began to rise and the fraction associated with benefits began to fall sharply. Two related features of the labor market that contributed to the trend reversal were the design of benefits packages and compensation differences between permanent and temporary workers.

Chart 3

## WAGES &amp; SALARIES AND BENEFITS COMPENSATION



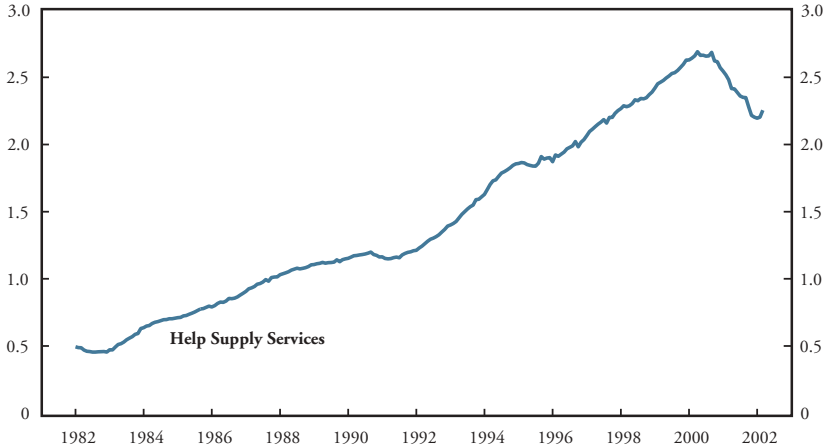
Source: Bureau of Economic Analysis

While wages and salaries are set according to the value of the job performed, many benefits, such as health and dental insurance, are identical for all employees at a firm. From 1960 to the mid-1990s, the cost of insurance increased rapidly. Between 1982 and 1993, the average annual real increase in employer costs per hour worked for health insurance was 7.3 percent, while real wages and salaries rose only 2.4 percent annually.<sup>8</sup> This rapid increase in insurance costs led to large increases in benefit costs of all employees.

In an effort to limit labor cost increases, many firms began employing more temporary workers, which for several reasons was a less expensive alternative to permanent workers during this period. First, these workers typically did not receive benefits; all of their compensation came in the form of wages. Thus, firms were able to limit the number of employees receiving increasingly costly insurance benefits. Second, labor costs for temporary and short-term workers were more flexible than costs for permanent positions. A survey of over 300 business people in New England showed that wages for newly hired short-term workers were more flexible during a recession than for newly hired permanent workers (Bewley).<sup>9</sup> For permanent positions, employers said that they preferred

*Chart 4*  
**TEMPORARY WORKERS**

Percentage of Total Nonfarm Employment



Source: Bureau of Labor Statistics

to pay similar wages to workers in similar positions to avoid morale problems associated with having large wage differentials. On the other hand, firms were willing to hire new employees for short-term positions at lower wages than those of current full-time employees. According to surveyed firms, a worker in a temporary position was less likely than a permanent employee to be discouraged by discovering that his wages were lower than a coworker's wages.

Empirical studies on changes in the labor force report that the number of temporary workers in the United States has dramatically increased in the last two decades. The majority of this growth has been due to changes in the hiring behavior of firms, as opposed to growth of a few industries that traditionally employ a large share of temporary workers. Employment of temporary workers has grown at an annual rate of over 11 percent since 1972, while total nonfarm employment has grown by 2 percent per year over the same period (Esteveo and Lach). As a result, temporary jobs account for a much larger fraction of total employment than in previous decades (Chart 4).



The advent of the temporary workforce has given employers more flexibility in their labor input, which should translate into dampened movements in the marginal cost of labor over the business cycle. Prior to the 1980s, strong employment increases during economic booms led to increases in total compensation, as both wages and benefits costs rose. Now, employers hire temporary workers to meet short-term increases in labor demand. They avoid paying for benefits and are not compelled to provide equal pay across positions. These changes may translate into smaller fluctuations in labor costs.

### *Capital*

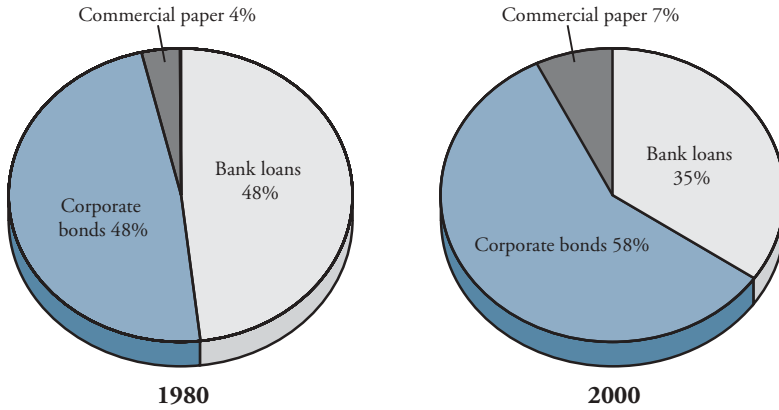
While a growing temporary help sector has increased flexibility of labor inputs, improved borrowing options for many firms have enhanced their access to funds for capital investment. In particular, developments in financial markets may have decreased the volatility of costs of capital acquisition at certain points in the business cycle. Firms benefit from lower financing costs through reduced costs of borrowing for all operational expenses. But the benefit is arguably largest for capital investment because changes in this input usually require long-term planning and the most financing.

Traditionally, many firms have relied on bank loans as their primary source of borrowed funds. While firms use this source of lending heavily, the supply of bank loans tends to fluctuate strongly with the business cycle. In particular, banks typically contract their loan supply to decrease their exposure to bad loans during downturns in the economy. This action reduces firms' opportunity to finance investment at the same time their revenue is falling due to lower demand for their products. As a result, financing costs on loans rise, or the opportunity to borrow is altogether eliminated, as banks may refuse to grant a loan. Many firms with profitable opportunities may be unable to acquire the financing necessary to undertake capital investment.

Since the 1970s, however, borrowing opportunities outside of the bank loan sector have expanded significantly. One sector in particular is the market for commercial paper, which expanded from financing 4 percent of the total debt of nonfinancial companies in 1980 to 7

Figure 1

## COMPONENTS OF DEBT FOR NONFINANCIAL COMPANIES



Source: Federal Reserve Board of Governors

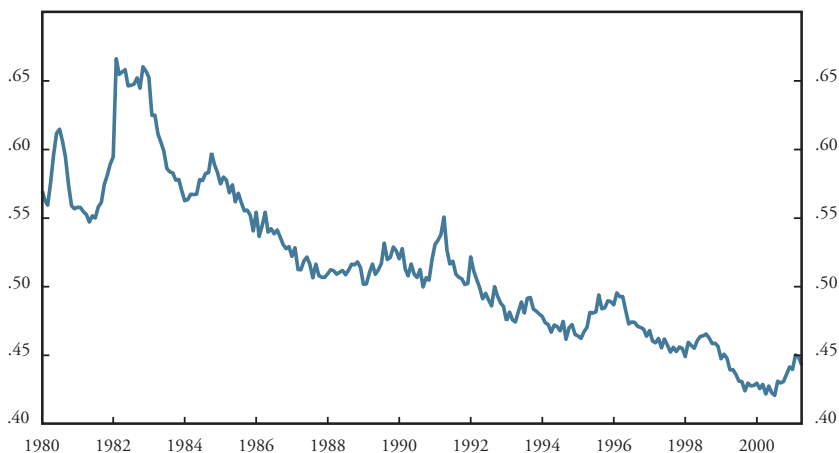
percent of debt in 2000 (Figure 1).<sup>10</sup> Although the commercial paper market is usually accessible only to large firms with strong financial records, this market has provided a valuable source of funds to this group of firms, especially during downturns in the economy. During periods of contractionary monetary policy, the firms with access to the commercial paper market make less use of bank loans and greater use of commercial paper. As the commercial paper market expands, the increases in financing costs and loan refusals associated with a decrease in bank lending should lessen (Kashyap, Stein, and Wilcox).

The long-term complement to commercial paper, corporate bond lending, has also expanded in recent decades. From 1980 to 2000, corporate bonds increased from 48 percent to 58 percent of total debt of nonfinancial companies. Due to the increase in commercial paper and corporate bond lending, the fraction of total debt financed by bank lending over the same period decreased from 48 percent to 35 percent. As a result, firms are less exposed to the fluctuations associated with changes in bank lending standards over the business cycle, and they can pursue capital improvement plans with less risk of sharp increases in borrowing costs associated with downturns in the business cycle.

Chart 5

## RATIO OF INVENTORIES TO SHIPMENTS

Inventories/Shipments Ratio



Note: Inventories are those of materials and supplies of total manufacturing. Shipments are those of total manufacturing.

Source: Census Bureau

### Materials

The behavior of input costs over the business cycle may have also changed as a result of improvements in management of materials. Over the past 20 years, changes in computer technology have allowed firms to improve their management of orders and stockpiles of materials, and thereby cut their inventory-to-sales ratio. This innovation is very important for firms because their use of materials is tied closely to production levels, which vary strongly over the business cycle (Basu). Since 1980, the level of manufacturing inventories of materials and supplies relative to shipments of manufactured goods has declined steadily (Chart 5).<sup>11</sup> These changes in inventory management have lowered two types of costs associated with materials: storage costs and financing costs.

The primary reason that firms keep an inventory of materials is to maintain an adequate supply for the production process. Firms want to avoid running out of a particular item, which may force the firm to stop

production. Shutdowns can be very costly for firms since they have to pay compensation for the idle workers and the machines are unable to generate revenue through production to pay for their acquisition costs.

However, maintaining an inventory of materials is not costless.<sup>12</sup> First, to keep a large quantity of materials on hand, firms need to have sufficient storage space. The costs of storage can be large depending on the physical size of the materials and the climate control required, especially for perishable goods. Second, the firm must finance the cost of the materials. Depending on the length of the production process and the stockpile of inventories, the time from the purchase of the materials by the firm to the time of the payment by the customer for the sale of the final good could be several months or longer. Until the payment for the final good is received, firms have to cover the costs of the materials.

In the past two decades, advances in information technology have allowed firms to dramatically improve the ways in which they monitor inventories, purchase materials, and track deliveries, thereby lowering inventory costs.<sup>13</sup> Through the use of computer databases, firms are now able to closely and inexpensively monitor their inventory levels. With nearly all firms better able to manage their inventories without causing disruptions in the production process from shortages of materials, they are less likely to experience large changes in stockpiles that occur during swings in the business cycle. As a result, when the economy slows, firms can more quickly reduce their orders of materials. And when orders drop, the producers of materials likewise can slow production more quickly than in previous business cycles. Similarly, in the case of an economic boom, firms can react more quickly to upturns in economic demand. The cumulative effect of all of these innovations in inventory management is that overall production responds more quickly to changing economic conditions, reducing the need for prices to fluctuate as surpluses and shortages of goods over the business cycle are limited.

### III. MARKUPS

Responding to the survey question asked by Blinder and others regarding factors affecting price adjustment, firms indicated that a second element of the pricing decision was the presence of “competitive pressures.” According to basic economic theory, the level of

competition in an industry influences the extent to which price is set above the marginal cost of production, commonly referred to as the markup. As competition increases, firms have less market and pricing power, leading to a reduction in the markups that are factored into prices. Changes in the magnitude of markups over time, as a result of changes in the structure of the economy, could lead to changes in observed pricing behavior.

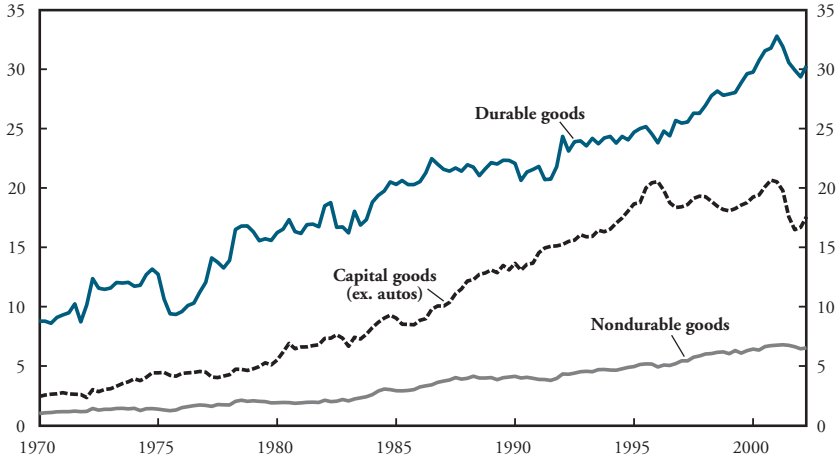
Several studies suggest that the magnitude of markups has declined over time due to increases in global competition. Beccarello found that heightened global competition in the period from 1971 to 1989 was associated with a decrease in the markup for firms. His study was based on manufacturing data for the seven major OECD countries. Similarly, Marchetti found a negative relationship between the level of competition and markups using data on Italian manufacturing plants from 1977 to 1995. For these plants, increases in competition, domestic and foreign, were associated with decreases in the size of the markup. In such a situation, firms may be forced to respond more quickly to changes in economic conditions because smaller profit margins provide less cushion against changes in cost. As a result of a quicker response on the part of firms, increases in competition may translate into less movement of markups over the business cycle than observed in the past.<sup>14</sup>

Markups should also be declining in the United States due to increases in global competition. While the studies mentioned above do not focus specifically on the United States, three economic indicators from U.S. trade data reveal significant increases in global competition. First, the percentage of imports in total consumption of durables goods (excluding automobiles) soared from 9 percent in 1970 to 30 percent in 2001 (Chart 6). Second, the percentage of imports in total consumption of nondurable goods rose from 1 percent in 1970 to over 6.5 percent in 2001 (Chart 6). Third, the percentage of imports in capital goods expenditures (excluding automobiles) rose from 2.5 percent in 1987 to nearly 17 percent in 2001 (Chart 6). These large increases, however, are only partially indicative of growing global competition. Some of the increase is also due to the specialization of production that has occurred as trade barriers have been lowered. For

Chart 6

## PERCENTAGE OF IMPORTS IN CONSUMPTIONS

Percentage



Source: Bureau of Economic Analysis

example, declines in the textiles and consumer electronics industries and growth in the high-tech sector in the United States over the past few decades reflect the effects of specialization.

#### IV. FREQUENCY OF ADJUSTMENT

Two additional responses to the survey by Blinder and others relate specifically to the implementation of a price change. When asked why firms do not change prices more frequently, many firms cited “costs of changing prices” and “it would antagonize or cause difficulties for our customers” as primary factors in their pricing decisions. These responses indicate that firms, when making their pricing decisions, consider direct and indirect costs of a price change in addition to factors that affect their desired price, such as the marginal cost of production and markup. Costs of price adjustment limit how frequently firms adjust prices. If these costs were to decrease over time, price adjustment might occur more often, as firms would find it less costly to react to changing economic conditions.

To identify the importance of price-adjustment costs, the survey by Blinder and others included several additional questions. The first question on adjustment costs was the following:

Another idea is that the act of changing prices entails special costs in itself, so firms hesitate to change prices too frequently or by too much. The costs we have in mind are *not* production costs, but costs like printing new catalogs, price lists, etc. or hidden costs like loss of future sales by antagonizing customers, decision making time of executives, problems with salespeople, and so on. Does your firm incur such costs when it changes prices?

In answering this question, 43 percent of firms reported they faced such costs, and an additional 21 percent said they faced adjustment costs, but that the costs were trivial in size. Nearly half of all firms in the manufacturing, services, transportation, communications, and utilities sectors reported the presence of significant adjustment costs, while costs for trade, construction, and mining sector firms were trivial or nonexistent for the most part.

The survey asked a follow-up question to identify the source of the adjustment costs. All firms that indicated the presence of at least a small adjustment cost were asked, "What is the nature of adjustment costs for changing prices in your company?" The top four response categories, ranked by the number of responses received, were the following: (a) "Printing new catalogs, new price lists, new packaging, etc."; (b) "Loss of future sales by antagonizing customers"; (c) "Informing salespeople and customers"; and (d) "Decision-making time of executives." Responses (a), (c), and (d) are often categorized under the general heading of "menu costs," a phrase that economists coined to describe price adjustment in the restaurant industry. In order for a restaurant to update its prices, it must pay the cost to reprint all of its menus. In current usage, the definition of menu costs includes all costs associated with a price change, not just the physical costs of implementing a price change. Such additional costs include the managerial time involved in making a pricing decision (response d) and the information costs associated with making and implementing a pricing decision (response c).<sup>15</sup> Response (b) does not fall in this category of direct costs. Instead, it points toward an indirect cost associated with a complex demand rela-

tionship between the producer and consumer in which demand for a product is determined not only by the posted price, but also by the change in the price from the previous period.

Empirical studies of menu costs also show that costs of price adjustment are significant for many firms. Labor costs associated with physically implementing price changes at five multistore supermarket chains are 0.7 percent of revenues, or 35.2 percent of net profits (Levy, Bergen, Dutta, and Venable). Total adjustment costs of an industrial manufacturer comprise 1.23 percent of revenues, or 20.3 percent of net profits (Zbaracki, Ritson, Levy, Dutta, and Bergen). These costs are split into the following categories: physical adjustment costs (3.3 percent), managerial costs (22.7 percent), and customer costs (74 percent). The customer costs consist of the time spent conveying price changes to customers, time spent negotiating prices with customers, and costs associated with loss of sales due to antagonizing customers.

Costs of price adjustment may have diminished in the past two decades due to technological changes. First, with the introduction of scanner technology and sales via the Internet, the costs of implementing new prices are lower. Previously, all items in retail stores were individually labeled. A price change required labeling all new items with the updated price as well as relabeling prices on all existing items on store shelves. Now scanner technology allows firms to post a single price on shelves instead of labeling individual items. The advent of the Internet also provides a retail sector where posted prices can be easily adjusted by simply modifying a computer document. For example, some large computer manufacturers modify their Internet-posted prices on a weekly, or even daily, basis.

Second, the information and managerial costs associated with pricing decisions are arguably lower due to the improvements in information technology. Many firms have improved access to the data on input costs needed to make a pricing decision. Computers provide more accurate record keeping, and scanner data provide improved marketing information on consumers, which in both cases allows some firms to better estimate the demand for their products.<sup>16</sup> Therefore, with improved information resources, it may be less costly and more profitable for firms to make pricing decisions more frequently.



Third, the cost of antagonizing customers, which was mentioned several times in the survey by Blinder and others, may now be smaller because consumers can more easily compare prices of different producers. If it is easier for consumers to track down prices for substitute goods, such as through searches on the Internet, consumers may make informed decisions on the purchase of a product whose price has increased, rather than simply “punish” a firm for what may be a well-warranted change in price.

Empirical evidence suggests that prices for some goods are changing more frequently than in previous years. Two of the most cited studies of infrequent price adjustment focus on data from newsstand prices of magazines and retail catalogs. From 1960 to 1979, newsstand prices for a set of 38 magazines changed on average every 4.9 months (Cecchetti). Prices for the same set of magazines changed more frequently from 1980 to 2000, on average every 3.3 months (Willis).<sup>17</sup> The data on retail catalogs cover the period from 1953 to 1987. On average, prices of 12 mail-order goods changed every 14.7 months (Kashyap). Evidence from recent years in this sector suggests that the frequency of price adjustment might have increased. For example, clothing prices in the consumer price index survey from 1995 to 1997 were adjusted on average every 3.3 months (Bils and Klenow). Differences in the samples, however, may bias this comparison since catalog prices tend to exhibit less frequent price adjustment than in-store prices.<sup>18</sup>

## V. INFLATION DYNAMICS

While it is evident that the pricing behavior of individual firms has changed, it is not clear how these changes in firm behavior will affect the aggregate price level and inflation. Changes in the timing and magnitude of price adjustments by firms could modify the persistence and volatility of inflation in numerous ways.

The changes in marginal costs discussed above are likely to decrease the volatility of inflation over the business cycle. As seen in the 1990s, increased flexibility of labor inputs have damped movements in the marginal cost of labor over the business cycle and, assuming no change in markups, will likely limit inflation increases during economic expansions. The 1990s experience also suggests that during an economic

downturn, the marginal cost of labor will not fall as quickly as in previous downturns because firms will lay off temporary workers while retaining the more highly paid permanent employees. As a result, inflation will not fall as much as in prior recessions. Expanded borrowing opportunities for firms may also dampen the volatility of inflation. Previously, the higher borrowing costs faced by many firms added pressure to increase prices, but with more borrowing options, these cyclical costs will decrease. Finally, advances in information technology will allow firms to improve management of materials inventories and production. Overall production will respond more quickly to changing economic conditions, reducing the excesses and shortages of goods over different points in the business cycle. As a result, fluctuations in prices typically associated with shortages of goods in economic booms and surpluses of goods in downturns may diminish.

Changes in the costs of price adjustment and markups may lead to a reduction in the persistence of inflation. If firms are able to adjust prices more quickly in response to changing economic conditions, due to lower costs of price adjustment, then aggregate inflation should more fully reflect the current changes in the economy and relate less to economic shocks in prior periods. This increased frequency of price adjustment will lead to a decrease in persistence—as inflation should more quickly return to its baseline following an economic shock. As increased global competition reduces firms' profit margins, smaller markups will force them to adjust prices more quickly to changing economic conditions in order to remain profitable. In terms of movements over the business cycle, the range over which the markup can fluctuate will be reduced. The change in the behavior of markups may reduce the persistence of inflation.<sup>19</sup>

## VI. CONCLUSION

The implications of recent structural changes for firm pricing behavior provide several insights into changes that may be occurring in inflation dynamics. As a result of structural changes in the past 20 years, many firms have access to a more flexible supply of labor and a more stable source of financing for investment. Advances in information technology have improved the management of materials inventories.

Combined with decreases in the costs of making price adjustments and increased competition, these changes have likely contributed to the observed decreases in persistence and volatility of inflation.

These structural changes may also have important implications for monetary policy. Historically, monetary policy actions have resulted in short-term changes in real output during an interval, roughly estimated between six and nine months, in which prices are slow to adjust. If firms now adjust their prices more quickly in response to actions by the monetary authority, then the ability of monetary policy to affect the real economy with a given change in interest rates has diminished. Imparting the same degree of stimulus will require a larger change in interest rates than was needed before the structural changes occurred. In this sense, the structural changes in the real economy may reduce monetary policy's influence on the business cycle. But the change in monetary policy's influence would not necessarily mean that the economy would experience larger swings in the business cycle. On the contrary, because firms now react more quickly to changing economic conditions, they can adjust prices and inventories to more quickly stabilize the economy than in the past.

## ENDNOTES

<sup>1</sup> Sims and Zha found no evidence of a permanent shift in policy behavior since 1950. Fair could not reject the hypothesis that the coefficients of an interest rate rule for monetary policy are identical for the periods 1951:Q1-1979:Q3 and 1979:Q4-1999:Q2. Clarida, Gali, and Gertler tested for changes in monetary policy behavior between the third quarter of 1979 and the end of 1996. They found few robust differences across various subsamples within this period. In support of a change in monetary policy, Romer and Romer documented evidence of a significant change in the conduct of monetary policy in the 1960s and 1970s.

<sup>2</sup> While Cogley and Sargent attributed most of the declining variability to declining persistence, Stock and Watson found little role for changing persistence, attributing most of the reduction in variance to less volatile shocks.

<sup>3</sup> The breaks in persistence, identified with Andrews' sup Wald test, have a significance level of 1 percent.

<sup>4</sup> The measure of persistence is calculated as the sum of the autoregressive coefficients on lagged values of inflation. The SIC criteria was used to determine the optimal number of lags of inflation to include the regression: three lags for core CPI and one lag for core PCE. The AIC criteria yields similar results. Confidence intervals were calculated using the Hansen bootstrap methodology, which estimates precise bound values in a variety of models, including cases when the largest root is close to 1. For PCE inflation, 90 percent confidence intervals are [0.88 1.01] from 1960:Q1 through 1992:Q1 and [0.12 0.55] from 1992:Q2 through 2002:Q2. The estimate of persistence for the later subsample presented in Table 2 lies outside the respective Hansen confidence interval, due in part to differences in the specification of the constant in each procedure. Estimates in Table 2 were computed under the restriction of no change in the constant across the subsamples, while the Hansen bootstrap methodology allowed for separate estimates of the constant.

<sup>5</sup> Contrary to the discussion of structural changes presented in this article, Cogley and Sargent argued that much of the change in inflation dynamics is due to the conduct of monetary policy.

<sup>6</sup> The survey was conducted between April 1990 and March 1992.

<sup>7</sup> In terms of gross output, labor is the second largest input behind materials costs. Labor accounts for approximately 35 percent of total gross input costs and materials account for 45 percent (Jorgensen, Gollop, and Fraumeni).

<sup>8</sup> From 1994 to 2001, this measure of real health insurance costs increased by 1.5 percent on average. Calculations are based on data from the Bureau of Labor Statistics.

<sup>9</sup> The survey was conducted between 1992 and 1994.

<sup>10</sup> A smaller sector that has also expanded sharply in the past 20 years, providing additional borrowing opportunities for some firms, is the market for junk bonds.

<sup>11</sup> The inventory-shipsments ratio is computed using data from the Census Bureau. These data are a subset of the data used to compute the more commonly referenced inventory-sales ratio, which includes data on works in process inventories and final goods inventories. The pattern displayed by the two ratios are qualitatively very similar.

<sup>12</sup> See Aguirregabiria for a study of inventory costs in the supermarket industry.

<sup>13</sup> Kahn and McConnell examined inventory behavior during the 2001 recession and concluded that firms were more successful in limiting excess inventories than in previous recessions.

<sup>14</sup> The impact on price behavior is less clear because of the empirical uncertainty regarding whether markups move countercyclically or procyclically over the business cycle. Bils and Kahn, and Rotemberg and Woodford found evidence of countercyclical markups. Chirinko and Fazzari found evidence of procyclical markups.

<sup>15</sup> See Wolman for a review of the literature on infrequent price adjustment.

<sup>16</sup> A recent article from the *Wall Street Journal* (September 18, 2002) provided several examples of new pricing methods introduced by industrial firms that are a result of improved information technology. These methods range from the creation of a “pricing team” of individuals to track regional trends in prices of competitors to the use of international surveys of customers to determine how much firms are willing to pay for an item.

<sup>17</sup> Data collected by Willis were used to compute the frequency of newsstand magazine price adjustment from 1980 to 2000. Average annual inflation was basically unchanged over the two periods. Inflation was 4.24 percent on average from 1960 to 1979 and 4.15 percent from 1980 to 2000.

<sup>18</sup> Including all items in the BLS survey, prices changed on average every 4.8 months from 1995 to 1997 and 84 percent of consumption fell into categories where prices change more frequently than once a year.

<sup>19</sup> Persistence will fall if markups move procyclically. But if markups move countercyclically, however, then inflation may in fact become more persistent.

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