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Cost Pass-Through in the U.S. Coffee Industry

Ephraim Leibtag, Alice Nakamura,
Emi Nakamura, and Dawit Zerom

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Cost Pass-Through in the U.S. Coffee Industry

Ephraim Leibtag, Alice Nakamura, Emi Nakamura, and Dawit Zerom

Abstract

A rich data set of coffee prices and costs was used to determine to what extent changes in commodity costs affect manufacturer and retail prices. On average, a 10-cent increase in the cost of a pound of green coffee beans in a given quarter results in a 2-cent increase in manufacturer and retail prices in that quarter. If a cost change persists for several quarters, it will be incorporated into manufacturer prices approximately cent-for-cent with the commodity-cost change. Given the substantial fixed costs and markups involved in coffee manufacturing, this translates into about a 3-percent change in retail prices for a 10-percent change in commodity prices. We do not find robust evidence that coffee prices respond more to increases than to decreases in costs.

Keywords: cost pass-through, retail prices, manufacturer prices, commodity costs, coffee.

About the Authors

Ephraim Leibtag is an economist with the Economic Research Service. Co-authors Alice Nakamura, Emi Nakamura, and Dawit Zerom worked on this project through a co-operative agreement with Harvard University and a data-sharing agreement with the University of Alberta, Canada. A. Nakamura is the Winspear Professor of Business at the University of Alberta, E. Nakamura is a doctoral candidate in the Department of Economics at Harvard University, and D. Zerom is an assistant professor in the Department of Finance and Management Science at the University of Alberta.

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Summary

A perennial issue in economics is the effect of changes in commodity prices on manufacturer and retail food prices. The traditional explanation is that the extent to which cost increases are "passed through" in a vertically organized production process depends on the market power of producers at each stage of production as well as the value added by each producer in the production process. The U.S. coffee industry is an excellent venue to study the issue of cost pass-through, since green coffee beans are important components of the marginal costs in this industry and are publicly traded commodities.

What Is the Issue?

This report uses unique data from the U.S. coffee industry to estimate how changes in commodity costs affect retail coffee prices. The results are relevant beyond the coffee industry, providing insight into how changes in commodity costs pass through to consumer and producer prices in other industries, too. "Cost pass-through" is a central issue in international economics since it determines how an economy responds to exchange rate adjustments as well as to changes in the prices of other imported commodities, such as oil.

What Did the Study Find?

Average manufacturer coffee prices dropped from 23 cents in 1997 to 17 cents per ounce in 2002. That drop corresponded with a fall in the coffee-bean share of the manufacturer price from 48 percent to 24 percent, while labor and other material costs rose from 15 percent to 32 percent.

The authors found that, on average, a 10-cent increase in green-coffee-bean prices per pound yields a 2-cent increase in both manufacturer and retail prices in the current quarter. If a cost change persists, it will be incorporated into manufacturer and retail prices approximately cent-for-cent with the commodity cost change. In addition, cross-sectional differences in prices are substantially larger at the retail than the wholesale level.

Since manufacturer prices adjust approximately one-for-one with commodity prices (rather than proportionally), the ratio between manufacturer prices and commodity costs rises as commodity costs rise. We do not find robust evidence that coffee prices respond more to increases than to decreases in costs.

How Was the Study Conducted?

An unusually rich collection of data on the ground-coffee industry was used to analyze the issue of cost pass-through. The data set included market-level average retail prices collected by Nielsen ScanTrack, market-level manufacturer prices collected by PromoData, and panel data collected by Nielsen Homescan to calculate the share of coffee by brand for each income level. Regression analysis was used to estimate the impact of changes in commodity prices on retail and manufacturer prices. These regressions are carried out for both absolute levels and in percentage terms. In addition, instrumental variable and fixed-effect methods were used to look at the manufacturer-retail price relationship and to analyze whether prices respond asymmetrically to cost increases and decreases.

Introduction

What impact do changes in commodity costs have on retail food prices? This question has been the subject of interest to policymakers, academic researchers, food producers, and industry analysts. The extent to which cost increases are passed through in a vertically organized production process plays a crucial role in determining how the economy responds to exchange rate fluctuations, and to price changes for imported commodities. This report uses unique coffee industry data to provide insight into how cost changes affect retail prices.

For U.S. consumers, coffee is an interesting case study since it is a major consumer product in the United States. Some 80 percent of U.S. adults drink coffee regularly, and over half drink coffee every day, at a rate of 18.6 gallons per capita per year (Brazil Information Center, 2002). As these consumers shift a greater share of coffee consumption to away-from-home and "on the go" eating occasions, price variation in retail coffee prices has increased, spurring greater interest in the dynamics of retail coffee prices.

For economists, coffee is an interesting case study because it is one of the world's most widely traded commodities and coffee beans are important components of the marginal costs in this industry. In addition, coffee is a publicly traded commodity with rich price data at different levels of production. The large amount of available coffee industry data—particularly manufacturer and retail price data—makes the industry well suited for an analysis of the magnitude of cost pass-through.

In this report, we use coffee industry data to estimate the impact of changes in costs on coffee prices. We regress current changes in prices on current and past changes in costs to estimate the effects of changes in commodity prices on manufacturer and retail prices for over 30 U.S. markets over the past decade. Our analysis provides estimates of the magnitude of cost pass-through and shows how firms adjust to changes in marginal cost.

A number of previous studies have analyzed the coffee industry. Gomez and Koerner (2002), Frey and Manera (2005), and Aguiar and Santana (2002) studied asymmetric price transmission in the coffee market. Azzam (1999) analyzed the implications of different models of competition for cost pass-through and price rigidity when retailers face barriers to adjusting their prices. Krivonos (2004), Shepherd (2004), and Durevall (2003) studied the coffee market.

A key difference between this study and previous studies is the use of coffee-price micro-data instead of food price indexes. A disadvantage of using price indexes to study pass-through is that the indexes are affected by changes in the composition of coffee products as well as changes in the prices of individual products. Our study is not subject to this. By analyzing wholesale prices for individual products, we are able to investigate price rigidity—i.e., the tendency of prices to remain fixed for long periods of time. By contrast, it is not possible to analyze price rigidity using food price indexes since the averaging inherent in price indexes smoothes over lumpy adjustments in individual price series.

The Coffee Value Chain

Almost all of the coffee consumed in the United States is imported from abroad (a very small amount of premium Kona coffee is grown in Hawaii). U.S. coffee manufacturers mostly purchase green coffee beans from Brazil, Colombia, Mexico, and Guatemala. In the United States, two main types of coffee are traded on the New York Board of Trade (NYBOT), Arabica and Robusta. Arabica is more expensive, but is generally preferred in terms of taste. Most U.S. supermarket coffees are a blend of Arabica and Robusta beans.

Coffee manufacturers grind and roast the green beans and sell the packaged product to supermarkets and grocery wholesalers. While most green coffee beans are purchased by roasters under long-term contracts, large coffee roasters also buy and sell on commodity markets. The prices observed on these commodity markets are thus an approximate measure of coffee roasters' marginal coffee bean costs.

The major players in the U.S. ground-coffee market include well-known manufacturers of consumer packaged goods. Procter & Gamble (P&G) produces Folgers, Kraft produces Maxwell House and Yuban, and Sara Lee produces Hills Bros., Chock Full O' Nuts, MJB, and Chase & Sanborn. P&G is the largest maker of household products in the United States, and Kraft Foods is the largest maker of food products in the United States.

Sales of ground coffee are highly concentrated among those companies. From 2000 to 2004, Folgers had a market share of 38 percent by volume, Maxwell House had a market share of 33 percent, and the Sara Lee brands had a market share of 10 percent. Private-label brands had a market share of about 8 percent, by volume, in ground coffee. Folgers' market share increased from 37 percent in 2000 to 42 percent in 2004, while the Sara Lee brands fell from 11 percent to 7 percent (Hoover's Incorporated, 2006).[1]

[1]Hoover's Incorporated is a business information service with indepth coverage of 42,000 of the world's top business enterprises.

The location of coffee-grinding production is highly centralized, based on easy access to seaports. P&G produces most of its consumer-market coffee in its New Orleans plant, and a smaller amount in its Kansas City, KS, plant. Kraft produces coffee at plants in Houston, TX, Jacksonville, FL, and San Leandro, CA. The Jacksonville plant is the largest among those. Starbucks has three roasting plants—in Seattle and Kent, WA, and in York, PA. Louisiana, Texas, and California were the States with the largest shipments of roasted coffee in 1992 and 1997 (U.S. Census Bureau, Survey of Manufacturers, 1997).

Packaged ground coffee is sold by manufacturers to retailers and grocery wholesalers. Of 20 large U.S. retailers, 11 used grocery wholesalers and the rest purchased directly from the manufacturer (Brazil Information Center, 2002). Most supermarkets that did not use grocery wholesalers still had a geographically decentralized purchasing system. Packaged coffee is typically delivered directly to the warehouses of supermarkets and grocery wholesalers, and the transportation cost is included in the price. Since inventory is expensive for grocery wholesalers, the wholesaler's goal is to carry as little inventory as possible while avoiding stock-outs.

The last link in the coffee value chain is the retailer. Recent developments have changed market dynamics at this level. Ground-coffee purchases at retail stores covered in our data have grown much more slowly than the 1-percent rate of U.S. population growth over the past 5 years. Purchases rose from 5.29 billion ounces to 5.39 billion ounces between the beginning of 2000 and the end of 2004. Coffee purchases at supermarkets peaked in 2001 at 5.51 billion ounces, just after retail and manufacturer prices fell. Purchases of regular (nondecaffeinated) ground coffee actually fell from 4.69 billion ounces to 4.66 billion ounces between 2000 and 2004. Some of this fall may be explained by increased sales of decaffeinated coffee. Regular coffee has become less popular relative to decaffeinated coffee over this period.

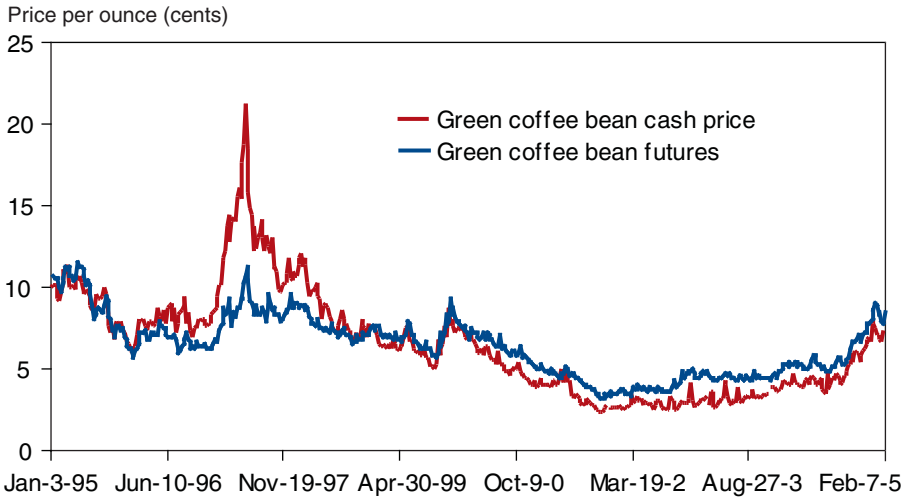
The downward trend in supermarket coffee sales has been offset by increases in coffee consumption away from home. Total U.S. retail sales at coffeehouses increased from $3.5 billion in 1998 to $6.9 billion in 2003 (Mintel International, 2004).[2] Total per capita coffee consumption showed no clear trend between 2000 and 2004, falling slightly from 1.66 cups per person per day in 2000 to 1.64 cups per person per day in 2004 (International Coffee Federation, 2005).

[2]Mintel International is a global supplier of consumer, media, and market research.

Coffee price and coffee-price terminology change along the market chain. The price that a consumer faces at a supermarket or other food retailer is termed the "retail price," the price charged by coffee manufacturers to retailers and wholesalers is the "manufacturer price," and the price of green coffee beans on commodity exchanges is the "commodity price" or "commodity cost." Given that retailers increasingly self-distribute, this analysis focuses on manufacturer and retail coffee prices.

Commodity prices are established in world markets and are highly volatile. Figure 1 presents a graph of coffee commodity prices over the past 20 years. Over the past 10 years, green-coffee-bean prices have ranged from less than

Figure 1
Green coffee bean cash and future price



Source: Author's analysis of New York Board of Trade data.

3 cents an ounce to over 20 cents an ounce. Coffee commodity prices fluctuate with supply, driven by the weather in coffee-producing countries, as well as the entry of new producers, such as Vietnam, into the international market (Lewin et al., 2004). The large decline in coffee prices during the late 1990s and the early 2000s is usually attributed to the expanded production capacities of Brazil and Vietnam. Figure 1 also shows the behavior of coffee futures prices over the last 10 years from the NYBOT. Coffee futures indicate the expectations of market participants. The futures prices in figure 1 are for prices 13 months in advance.

Retail coffee prices reflect some of the dynamics in coffee demand. Retail coffee sales are highly seasonal. Coffee sales (by volume), on average, are 10-15 percent higher in November and December than in January, and about 10 percent lower from May to September. The summertime drop in sales may be a consequence of high temperatures. The November-December increase in sales is consistent with the "seasonal cycle" in aggregate output documented by Barsky and Miron (1989).

Retail prices also have a small seasonal cycle as prices are lower by almost 1 cent per ounce in November and December than in January (Barsky and Miron, 1989). The low prices are associated mostly with sales. Regular (nonsale) prices during this period are only a few tenths of a cent lower than in January. While some of the purchases in November and December may be associated with the Christmas season alone, sales and promotions also contribute to the end-of-year purchasing boom.

Data Description

Data on commodity prices are from the New York Board of Trade (NYBOT). The commodity prices quoted on the NYBOT are a "basis" price that is used to price a variety of coffee types.[3] The price of coffee beans on the NYBOT varies by the point of delivery.[4]

Average retail prices were calculated using market-level Nielsen ScanTrack data for 2000 to 2004. The data are collected in 50 Nielsen-defined markets from supermarkets with at least $2 million in annual sales. The size of the Nielsen market generally depends on how populated the area is. Less populated regions have larger geographic market sizes, but the markets are generally larger than cities. The Nielsen data also include population information for each market area, and these markets cover most of the population in the continental United States.

In 2002, 5.5 billion ounces of roasted ground coffee were sold at supermarkets that were covered in the Nielsen data. In 2002, $2.8 billion worth of ground roasted coffee (valued at manufacturer prices) was shipped from U.S. manufacturing plants. The average manufacturer price for the 16.5 billion ounces of roasted ground coffee shipped from U.S. manufacturing plants in 2002 was 17 cents per ounce (U.S. Census Bureau, Census of Manufacturers, 2002). This is about three times the amount sold at Nielsen-covered supermarkets. This difference arises from the fact that coffee is sold at non-Nielsen-covered retailers, restaurants, and other food-away-from-home outlets, and is purchased for commercial uses.

Despite the fact that coffee sales by supercenters and some other nontraditional retailers are not covered in the Nielsen data, Hausman and Leibtag (2004) found that the rate of price change did not vary significantly between supermarkets and nontraditional retailers. This implies that the dynamics of pass-through studied with these data are applicable across the general food-at-home market for coffee. About 70 percent of whole-bean or ground-roasted coffee sold to consumers is purchased at supermarkets, implying that inferences may be drawn about coffee price pass-through from retail price data (Brazil Information Center, 2002).

Market-level manufacturer prices collected by Promodata contain pricing information for more than 50 markets, matching the Nielsen data for supermarkets. Promodata collects data from the largest grocery wholesaler in each market, but does not identify the wholesaler for confidentiality reasons. These data identify the price per case charged by the manufacturer to the wholesaler, as well as information about trade deals occurring in the market. PromoData data are from 1997 through 2004.

Nielsen Homescan panel data for 1998-2003 were used to calculate the demographics of customers of different coffee brands. The Nielsen Homescan data set uses a stratified sample of households across the United States and includes purchase as well as demographic information for sample households. The panel is geographically dispersed and is demographically

[3]Arabica beans are rated on a 5-point scale. Other types of coffee are priced at a premium or deficit relative to Arabica.

[4]The U.S. delivery points include the Port of New York District, the Port of New Orleans, the Port of Houston, and the Port of Miami.

balanced in terms of household income, family composition, education, and other characteristics. Each household is equipped with an electronic home-scanning unit, and household members record every universal product code (UPC) for food purchases via scanning in UPCs or by entering the relevant product code for non-UPC food purchases. Panel members record purchases, capturing not only what is purchased, but also where the purchase was made and whether the purchase was a promotional, sale, or coupon item.

How Important Is the Coffee Bean in Determining Costs?

The coffee bean is clearly an important part of the cost of packaged ground coffee—but how important? In 1997, the total value of U.S. roasted coffee shipments was about $6.8 billion (U.S. Census Bureau, Census of Manufacturers, 1997). Materials—including coffee beans, packaging, and fuels—accounted for $3.88 billion, while total labor costs were $317 million. Green coffee beans alone cost $3.15 billion.[5] Since average manufacturer prices were approximately 23 cents per ounce in 1997, this implies that approximately 11 cents per ounce was spent on coffee beans, 3.5 cents on labor and other materials costs, and 9-10 cents constituted the average gross margin.

By 2002, the total value of roasted coffee shipments had fallen to $3.93 billion, according to the Census of Manufacturers. Materials costs were $1.96 billion, of which green coffee beans alone accounted for $974 million. Labor costs were $299 million. Since the average manufacturer price was 17 cents per ounce in 2002, this implies that approximately 4 cents per ounce was spent on coffee beans, 5.5 cents on labor and other materials costs, and 7-8 cents constituted the average markup. Evidently, the dramatic changes in commodity prices between 1997 and 2002 had a substantial impact on the share of marginal cost accounted for by coffee beans.

The manufacturer's gross margin, defined as the difference between a manufacturer's selling price and the manufacturer's noncapital costs, can be estimated using the Annual Survey of Manufacturers data from the coffee and tea category and dividing the value of total shipments minus material and labor costs by the value of total shipments (table 1).[6] Comparing these estimates with figure 1 indicates that manufacturers' gross margins tend to be particularly low when commodity prices are high (e.g., in 2000) and particularly high when commodity prices are low (e.g., in 2002).

Table 1
Coffee and tea manufacturers' gross margin

Year	Average gross margin
	Percent
1997	39
1998	40
1999	39
2000	39
2001	40
2002	44
2003	35

Source: Authors' analysis of U.S. Census Bureau's Survey of Manufacturers coffee and tea data.

[5]One problem with Census of Manufacturers data from the U.S. Census Bureau is that it is not entirely clear how firms report the cost of green coffee beans used in a particular year. These reports probably reflect historical costs, whereas the relevant statistic from the perspective of economic models of pricing is typically replacement cost.

[6]These estimates are somewhat imprecise because tea is included in the coffee and tea category.

Differences in Prices Across Markets

Different fields of economics make contrasting assumptions on whether, theoretically, prices differ across markets. International economics researchers often make the assumption that the possibility of arbitrage across markets implies that the same product must sell for the same price in different markets, while industrial organization economists often make the assumption that a firm can set different prices in geographically distinct markets. In the case of the coffee market, Hilke and Nelson (1989) argue, as part of an antitrust case against Maxwell House, that "while transshipment does occur . . . it is sufficiently constrained that it does not equalize prices."

This section analyzes how much both retail and manufacturer prices differ across markets using Nielsen retail price data from 2000 through 2004 and Promodata manufacturer prices from 1997 through 2004.[7]

[7]For manufacturer prices, exact sample dates differ by market.

While there are statistically significant differences in manufacturer prices across markets over the entire sample period, the differences are fairly small in economic terms: no more than half a cent per ounce, or 2-3 percent of the manufacturer price. However, when comparing specific products across markets at one point in time, the differences are larger; 1 to 2 cents or 5-10 percent of the manufacturer price.

Manufacturer price data distinguish between changes in "regular" manufacturer prices and trade deals. Trade deals take a variety of forms, sometimes requiring that the retailer show evidence that a promotion has been carried out for the product.[8] Trade deals are typically quoted per case, and often last for a month or more. The size and frequency of trade deals differ across markets and product types. The median trade deal lasts for 3 weeks, although 5 percent of trade deals last for 25 weeks or more.[9] Differences in manufacturer prices across markets arise both from differences in "regular" manufacturer prices, as well as different trade deals, though the cross-sectional differences in trade deals are much larger than the regular price differences.

[8]Trade deals generally take three forms: 1) off-invoice allowances that generally do not entail wholesale or retailer action; 2) bill-back allowances, which are promotions that often require either advertising, displays, or a minimum amount of sales by the wholesaler or retailer; or 3) category development funds, which are based on various arrangements to promote a specific product or group of products.

[9]Some markets, such as Chicago, IL, have deals in effect for more than 20 percent of the UPC-week observations, while other markets, such as Sacramento, CA, have deals in effect for less than 7 percent of the observations.

In the past, some trade deals were used to price-discriminate across markets, according to Maxwell House internal documents cited by Nelson, Siegfried, and Howell (1992). In the 1970s, Maxwell House was owned by the General Foods Corporation. According to Maxwell House documents, General Foods' trade-dealing practices in the 1970s were based on percentages of competitive share. For example:

- If the competitive share was less than 30 percent of Maxwell House's share, the competitor was not a significant factor;
- If the competitive share was between 30 percent and 50 percent of Maxwell House's share, Maxwell House's shelf-pricing objective was to be within 10 cents per pound above the competitor;
- If the competitive share was between 50 percent and 70 percent of Maxwell House's share, Maxwell House's shelf-pricing objective was to be within 10 percent of the competitor;

- Otherwise, Maxwell House's objective was to obtain absolute parity (Nelson, Siegfried, and Howell, 1992).

A clear relationship did not appear to exist between manufacturer market prices or relative prices and the Herfindahl index of the market or the one-firm concentration ratio. We found (as did Hilke and Nelson (1989)), that highly rivalrous markets such as Chicago tend to have many trade promotions.

Consistent differences in prices for the same item in different markets are much more common for retail prices. Retail coffee prices in California were, on average, 4 to 5 cents higher than the national average price during 2000-04. Moreover, the time-series variation in coffee prices is much less correlated across products for retail prices than for manufacturer prices. For manufacturer prices (either Folgers or Maxwell House), 40 to 50 percent of the variation in market-specific growth rates of coffee prices can be explained by national trends. For retail prices, 10 to 15 percent of the variation can be explained by national trends.[10] This implies that other market-specific effects, such as retail food market competition, have a bigger effect on retail prices than on manufacturer prices.

[10]These statistics are based on regressions of the growth rate of coffee prices on year and quarter fixed effects.

Responding to Costs

Variation in coffee bean (commodity) costs is a major cause of variation in manufacturer prices. Table 2 presents regressions of changes in coffee prices on lagged changes in coffee bean costs. The first panel presents results for manufacturer prices, while the second panel presents results for retail prices. For comparability, the statistics are for 2000-04. The "base" prices don't include sales (in the case of retail prices) or trade deals (in the case of manufacturer prices) in order to estimate the impact of commodity prices on both regular prices and prices including sales and promotions.

A standard specification of a cost pass-through regression from the international economics literature was used (see Goldberg and Campa, 2004). In particular, we regress current changes in prices on current and past changes in costs to analyze quarterly data. This is because coffee commodity costs are highly persistent: the hypothesis of a unit root cannot be rejected.[11] The pass-through regressions may be seen as tracing out an impulse response function to changes in costs: the estimated coefficients indicate what fraction of the change in commodity costs at a certain point in time is reflected in current price changes. The sum of the coefficients gives the longrun response of prices to costs (Goldberg and Campa, 2004).[12]

[11]An alternative approach would be to estimate an error-correction model, as used by Gomez and Koerner (2002). However, there may be no cointegration between coffee prices and commodity costs over the time period. In addition, methods for analyzing cointegration in panel data are new and developing.

[12]The number of lags in the regression were selected such that adding additional lags did not affect the longrun rate of pass-through.

Table 2
Regression of current price changes on past changes in commodity cost[1] (quarterly data)

Variable	Manufacturer prices		Retail prices	
	Base	Net	Base	Net
Δ Commodity cost (t)	0.272	0.215	-0.122	0.142
	(0.055)	(0.066)	(0.020)	(0.039)
Δ Commodity cost (t-1)	0.480	0.488	0.500	0.450
	(0.034)	(0.039)	(0.138)	(0.024)
Δ Commodity cost (t-2)	0.003	0.002	0.301	0.015
	(0.028)	(0.024)	(0.009)	(0.017)
Δ Commodity cost (t-3)	-0.031	0.030	0.040	0.072
	(0.025)	(0.024)	(0.009)	(0.016)
Δ Commodity cost (t-4)	-0.017	0.075	-0.043	0.137
	(0.029)	(0.027)	(0.010)	(0.017)
Δ Commodity cost (t-5)	-0.072	0.078	0.036	0.078
	(0.023)	(0.029)	(0.009)	(0.016)
Δ Commodity cost (t-6)	-0.038	-0.029	0.118	0.006
	(0.024)	(0.026)	(0.009)	(0.020)
Constant	-0.005	-0.0001	0.001	0.006
	(0.0003)	(0.001)	(0.0002)	(0.0003)
Quarter dummies	Yes	Yes	Yes	Yes
Number of observations	2,506	3,649	46,243	46,243
R^2	0.189	0.114	0.060	0.079

Source: Authors' analysis of Nielsen, Promodata, and New York Board of Trade data, 2000-04.

[1]The dependent variable in these regressions is the change in price in a particular quarter. The standard errors are clustered by unique product and market for the manufacturer price regressions.

The regressions indicate that, on average, a 10-cent increase in green-coffee-bean prices yields approximately a 2-cent increase in both net manufacturer and net retail prices in the current quarter (2.1 cents for wholesale prices and 1.4 cents for retail prices). If a cost change persists for several periods it will be incorporated into manufacturer prices approximately cent-for-cent with the size of the change in the commodity cost.

A cent-for-cent decrease in prices due to decreasing costs does not imply a constant percentage markup of prices over marginal costs. Indeed, for the percentage markup to remain fixed, prices would have to fall more than one for one with costs. This distinction is particularly important when fixed costs are substantial, so gross margin above marginal cost is high, as is the case for ground coffee.

Consider the dramatic fall in coffee prices between the first quarter of 2000 and the last quarter of 2001, when coffee beans traded on the New York Board of Trade (NYBOT) lost about 65 percent of their original value. The per-ounce cost of coffee beans fell by about 5.5 cents, while average manufacturer and retail coffee prices both fell by 4 to 5 cents. While the retail and manufacturer price changes are similar in magnitude to the change in commodity costs, the percentage change is very different. As a consequence, the percentage markup of prices over marginal costs for coffee manufacturers increased dramatically during this period.

To follow up on this idea, cost pass-through regressions for prices and costs are presented in log form. In these regressions, the coefficients indicate the percentage change in prices associated with a given percentage change in costs.

Recall that the sum of the coefficients for the different lags can be interpreted as the long-term effect of a cost shock. Summing the coefficients in this way yields a longrun rate of pass-through of 0.247 for net retail prices and 0.262 for net manufacturer prices. This implies that, on average, a 10-percent increase in manufacturer green-coffee-bean prices yields about a 3-percent increase in retail and manufacturer prices. Thus, the regression in logs provides direct evidence that a given percentage change in cost translates into a much smaller percentage change in manufacturer or retail prices.

There are two reasons for the difference between pass-through in levels and pass-through in logs. First, there is a substantial markup of prices over marginal costs in this industry. Second, variable inputs other than green coffee beans contribute to marginal cost. These factors drive a wedge between commodity costs and prices, implying that full pass-through, in percentage terms, differs substantially from cent-for-cent pass-through.

A report on prices for soluble (instant) coffee in the United Kingdom finds similar results on the nature of price adjustment. According to the United Kingdom Competition Commission report, “An econometric estimation of the relationship between green-coffee-bean prices and retail selling prices over the last 10 years showed that, for Maxwell House soluble coffee, a 1-pound increase in the cost of beans for delivery in 45 days led to an increase of more or less exactly 1 pound in retail selling prices over a year; over half of that increase occurred within 4 months” (United Kingdom Competition

Commission, 1991). A similar rate of pass-through was also found for Sweden, Denmark, and Finland (Durevall, 2003). This "additive" pass-through is also found in the gasoline market (Borenstein et al., 1997).

In interpreting this type of cost pass-through regression, it is not clear whether manufacturer prices respond to lagged changes in commodity prices because of actual delays in response or because manufacturer prices respond only to changes in commodity costs that are expected to persist for some period of time. These two effects may be confounded because changes in commodity costs that have already lasted for several periods may also be more likely to persist in the future.

The R^2 values for the regression results presented in tables 2 and 3 reiterate that variation in green-coffee-bean prices explains a much higher share of the variation in manufacturer than in retail prices. The main reason for this difference is that there is a greater deal of high-frequency "noise" in retail prices than in manufacturer prices. Much of this noise is associated with retail promotions. The explanatory power of the regression is much higher if regular retail prices, excluding promotional prices, are used.

Table 3
Regression of log current price changes on log past changes in commodity cost[1] (quarterly data)

Variable	Log manufacturer prices		Log retail prices	
	Base	Net	Base	Net
Δ Commodity cost (t)	0.122	0.117	-0.034	0.062
	(0.014)	(0.016)	(0.006)	(0.012)
Δ Commodity cost (t-1)	0.148	0.151	0.125	0.104
	(0.010)	(0.011)	(0.004)	(0.016)
Δ Commodity cost (t-2)	-0.016	-0.024	0.092	0.012
	(0.009)	(0.009)	(0.003)	(0.048)
Δ Commodity cost (t-3)	-0.034	-0.010	0.015	0.027
	(0.008)	(0.008)	(0.003)	(0.039)
Δ Commodity cost (t-4)	-0.008	0.028	-0.022	0.042
	(0.011)	(0.011)	(0.004)	(0.034)
Δ Commodity cost (t-5)	0.033	0.024	0.0001	0.007
	(0.008)	(0.009)	(0.003)	(0.017)
Δ Commodity cost (t-6)	-0.027	-0.041	0.040	-0.018
	(0.009)	(0.010)	(0.003)	(0.035)
Constant	-0.036	-0.009	0.010	0.029
	(0.002)	(0.003)	(0.001)	(0.011)
Quarter dummies	Yes	Yes	Yes	Yes
Number of observations	2,506	3,649	46,243	46,243
R^2	0.194	0.1316	0.053	0.071

Source: Authors' analysis of Nielsen, Promodata, and New York Board of Trade data.
[1]The dependent variable in these regressions in the log change in price in a particular quarter. The standard errors are clustered by brand.

Asymmetric Cost Adjustment

The public, industry analysts, and government agencies, as well as the academic literature, have long been interested in the question of whether adjustments to costs are asymmetric between cost increases and decreases. In particular, a number of markets have demonstrated that prices adjust more rapidly to cost increases than decreases. Table 4 tests for this type of asymmetry, presenting regressions identical to those in table 2 except that separate terms are included for commodity cost increases and decreases in the current period.

These regressions are inconclusive on the issue of asymmetric price adjustment. The retail data appear to support the view that prices respond more quickly to price decreases than increases, while the manufacturer data do not show evidence of an asymmetry. Specifications allowing for asymmetric responses to changes in costs at 2, 3 and 4 lags were considered. The estimated models did not systematically support the view that prices respond more quickly to either price increases or decreases. This finding is consistent with the findings in Gomez and Koerner (2002) for the United States, France, and Germany. By contrast, Aguiar and Santana (2002) found evidence that increases in commodity costs are passed on more than decreases for a high-inflation period in Brazil, suggesting that inflation may influence the extent of asymmetry in pass-through. Asymmetric price adjustment is difficult to investigate using these data partly because commodity cost increases for green coffee beans have generally occurred more rapidly than decreases over the period studied.

Table 4
Regression of current price changes on past changes in cost with asymmetry terms[1] (quarterly data)

Variable	Log manufacturer prices		Log retail prices	
	Base	Net	Base	Net
Δ Cost +(t)	0.185	0.099	-0.209	-0.008
	(0.065)	(0.105)	(0.024)	(0.048)
Δ Cost –(t)	0.428	0.318	0.055	0.448
	(0.076)	(0.099)	(0.037)	(0.082)
Δ Cost (t-1)	0.439	0.464	0.449	0.369
	(0.029)	(0.052)	(0.016)	(0.033)
Δ Cost (t-2)	0.002	0.043	0.301	0.016
	(0.028)	(0.035)	(0.009)	(0.017)
Δ Cost (t-3)	-0.016	0.043	0.056	0.101
	(0.024)	(0.035)	(0.009)	(0.017)
Δ Cost (t-4)	0.005	0.049	-0.020	0.178
	(0.027)	(0.038)	(0.011)	(0.020)
Δ Cost (t-5)	0.053	0.047	0.015	0.040
	(0.024)	(0.029)	(0.010)	(0.018)
Δ Cost (t-6)	-0.055	-0.031	0.099	-0.026
	(0.025)	(0.035)	(0.010)	(0.021)
Constant	-0.005	-0.002	0.002	0.007
	(0.0003)	(0.001)	(0.0002)	(0.0003)
Quarter dummies	YES	YES	YES	YES
Number of observations	2506	2506	46243	46243
R^2	0.190	0.101	0.061	0.079

Source: Authors' analysis of Nielsen, Promodata, and New York Board of Trade data.
[1]The dependent variable in these regressions is the change in price in a particular quarter. The standard errors are clustered by brand.

Pricing Strategy Patterns

The desire to smooth prices has been posited by coffee manufacturers as one explanation for not fully adjusting prices to changes in costs. In an investigation by the United Kingdom Competition Commission, Nestle commented:

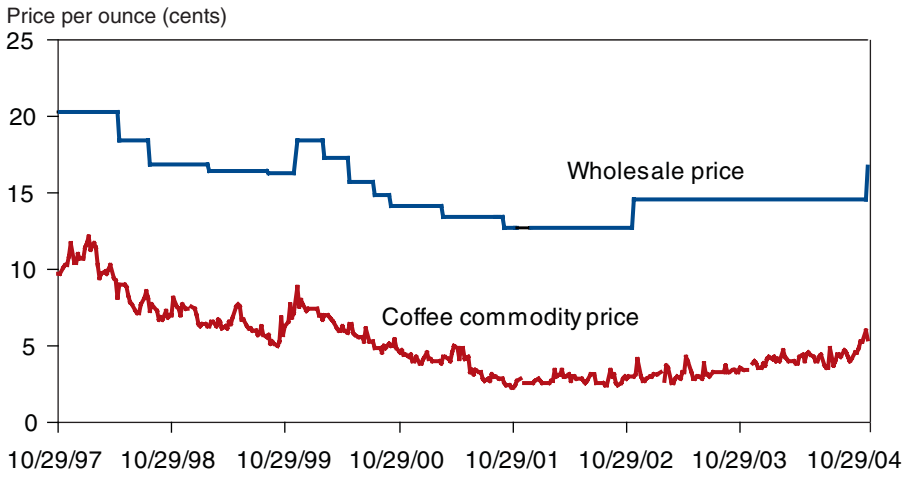
> "In making price changes, Nestlé was influenced first by the need to avoid price volatility that could confuse the customer and be difficult for the trade to manage. Secondly, Nestlé aimed to smooth price increases to avoid sharp changes that could damage the confidence of the consumer. The company said that the history of recent price changes, given below, led to results which were overall more satisfactory to consumers than prices which changed more frequently in response to changes in green-coffee-bean prices, which fluctuated daily" (United Kingdom Competition Commission, 1991).

Starbucks spokeswoman Helen Chung stated, "We do not change our prices based on short-term fluctuations in the coffee market" (Seattle Times, December 7, 1999). P&G commented in conjunction with its 2004 price increase that P&G "increases product prices when it is apparent that commodity price increases will be sustained" (Associated Press, Dec. 10, 2004). Coffee manufacturers often cite movements in futures prices as motivation for price adjustments, further corroborating their stated desire to smooth prices.

Not evident from market-level averages is the fact that individual manufacturer prices often remain fixed for long periods of time. Figure 2 presents a typical manufacturer-price series for Folgers coffee.

Historically, adjustments in prices have occurred primarily when coffee commodity prices are relatively volatile. Table 5 presents the standard deviation of weekly coffee commodity prices by year, as well as the average frequency of manufacturer price adjustments during the year. These statis-

Figure 2
A typical wholesale price series



Source: Author's analysis of Promodata wholesale-price data and New York Board of Trade commodity data.

Table 5
Frequency of price adjustment and standard deviation of commodity costs

Year	Average number of price changes	Standard deviation of commodity cost index
1997	4.5	2.1
1998	1.7	1.6
1999	1.7	0.8
2000	3.2	0.9
2001	1.1	0.4
2002	0.5	0.3
2003	0.2	0.1
2004	0.7	0.5

Source: Authors' analysis of Nielsen, Promodata wholesale price data and New York Board of Trade commodity data.

tics calculate the number of price adjustments, not including the price adjustments associated with trade promotions.

There is a strong relationship (correlation coefficient of 0.84) between the frequency of price adjustments at the manufacturer level and the volatility of coffee bean prices over a given period. For example, the lowest standard deviation of weekly commodity costs and the lowest average frequency of manufacturer price adjustments both occur in 2003, while the highest standard deviation of weekly commodity costs and the highest average frequency of manufacturer price adjustments occur in 1997.

The data show, that in some years, price adjustments were very infrequent. In 2003, the average frequency of manufacturer price adjustments in the year over the different UPCs was 0.2 times and the standard deviation of weekly coffee bean prices was about 0.1 cent. Taking into consideration that green-coffee-bean costs constituted about 40 percent of marginal costs in 2003, this implies that the standard deviation of marginal costs was about 2 percent during that year.[13]

[13]In calculating this figure, the fact that green coffee beans lose 15 to 20 percent of their weight during the roasting process was taken into consideration.

Another way of analyzing the data is to compare the frequency of price adjustments across brands (table 6). The frequency of price adjustments is relatively similar across the three major coffee brands: Folgers, Maxwell House, and Hills Bros. Starbucks is an outlier in having extraordinarily few price adjustments. One potential explanation for Starbucks' behavior may be that it is a premium product, with a considerably higher price range and perceived quality.

Table 7 uses Nielsen Homescan statistics to summarize the household income characteristics of customers of different brands of coffee and shows clearly that while customers of Folgers, Maxwell House, and Hills Bros. have similar demographic characteristics, far more (74 percent) Starbucks customers are from the upper two income brackets. These high-income customers are likely to have lower price sensitivity, potentially decreasing the incentive for Starbucks to adjust its prices.

Table 6
Frequency of price adjustment by coffee brand, 1997-2005

Brand	Average frequency of price adjustment[1]
Folgers	1.77
Maxwell House	1.36
Hills Bros.	1.59
Starbucks[2]	0.46

Source: Authors' analysis of Promodata wholesale price data.

[1]The average frequency of price adjustment is calculated for weekly data for all universal product codes (UPCs) observed over 1997-2004. Since not all UPCs are observed in every time period, the sample period is somewhat different for the different brands.

[2]"Starbucks" refers to coffee products sold in grocery stores and supermarkets and not to coffeehouses.

Table 7
Demographics of coffee customers by brand, 1998-2003

	Income range			
	Under $30,000	$30-50,000	$50-70,000	Above $70,000
	Percent of sales			
Folgers	25	30	23	22
Maxwell House	23	31	21	24
Hills Bros.	22	31	26	20
Starbucks[1]	07	19	23	51

Source: Authors' analysis of Nielsen Homescan data.

[1]"Starbucks" refers to coffee products sold in grocery stores and supermarkets and not to coffeehouses.

Price Change Announcements

Large coffee manufacturers often announce national price changes. Table 8 is a summary of these announcements for 1997-2005, showing that coffee manufacturers announced both price increases and decreases over this period. There were essentially no announcements of price changes between fall 2001 and fall 2004.

To what extent are price changes coordinated nationally for a particular brand? Do price changes always coincide with announcements (and vice versa)? In order to address these questions, figures 3, 4, and 5 present histograms of the frequency of price adjustments for Folgers, Maxwell House, and Starbucks.[14]

[14]For the purpose of creating these graphs, a price increase is coded as a "1"

These figures show a great deal of coordination in price changes, both within brands and between Folgers and Maxwell House. For both Folgers and Maxwell House, there are several periods in which over 50 percent of prices adjust. There are also many periods in which less than 2 percent of prices adjust. While Folgers and Maxwell House instituted many price changes from 2001 to 2004, they were in general far less synchronized than the price changes that occurred in 2000 and before. Thus, price change

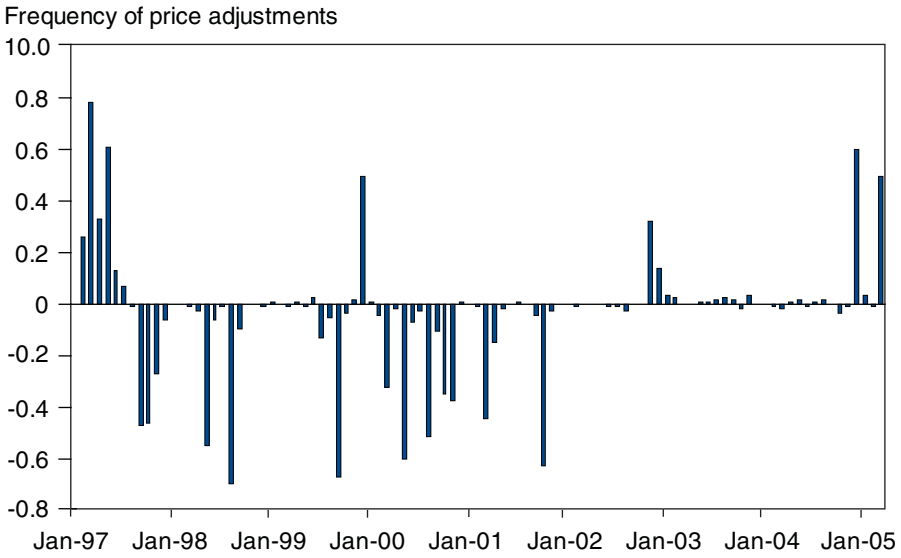
Table 8
Historical coffee price announcements

Date	Announced price increase	Announced price decrease
March 2005	Kraft, Procter & Gamble, Sara Lee	
Dec. 2004	P&G	
Sept. 2004	Starbucks[1]	
Sept 2001		P&G
April 2000		P&G
December 1999		P&G
August 1999		Kraft, P&G
July 1998		P&G
May 1998		P&G, Kraft
Sept. 1997		P&G
July 1997		P&G
May 1997	Starbucks, Kraft, P&G	
March 1997	Starbucks, Folgers	

Source: Results of Lexis-Nexis search for 1997-2005.

[1]"Starbucks" refers to coffee products sold in grocery stores and supermarkets and not to coffeehouses.

Figure 3
Average indicator for Folgers price increase/decrease



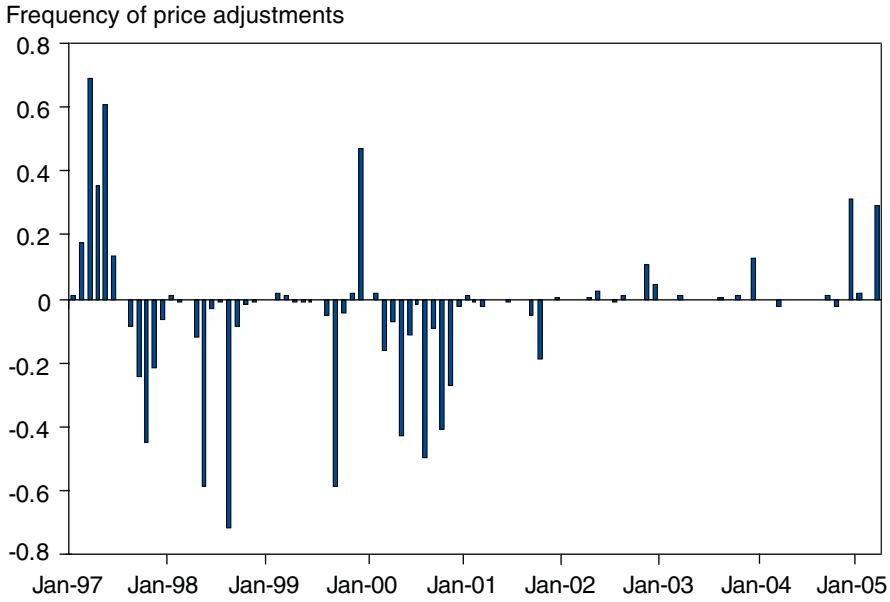
Source: Authors' analysis of Promodata wholesale-price data.

announcements tend to accompany price changes that are synchronized across products and markets.

Folgers is considered a price leader in the market for ground coffee. Regressing current price changes on recent price changes by Folgers or Maxwell House did not, however, reveal significant differences in the tendency of Folgers price changes to precede price changes by other brands. Of course, it may be that Folgers nevertheless announces price changes before other coffee brands. Indeed, newspaper announcements of coffee

Figure 4

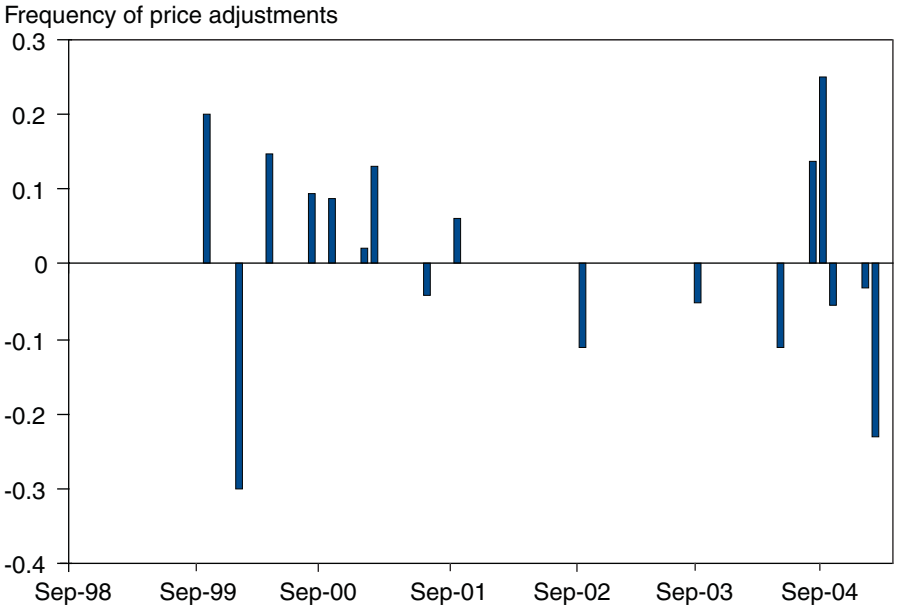
Average indicator for Maxwell House price increase/decrease



Source: Authors' analysis of Promodata wholesale-price data.

Figure 5

Average indicator for Starbucks price increase/decrease



Source: Authors' analysis of Promodata wholesale-price data.

price changes often indicate that Maxwell House is "following the lead of Folgers" in making a price change.

Pass-Through From Manufacturer to Retail Prices

How quickly and to what extent do retail prices adjust to manufacturer prices in the coffee market? Table 9 investigates this question. One difficulty in estimating the effect of manufacturer prices on retail prices is that the manufacturer prices observed in our dataset may not be exactly the wholesale prices paid by a particular retailer. This measurement error has the potential to bias downward the estimates of pass-through from manufacturer to retail prices. To avoid this bias, table 9 uses two lags of commodity cost changes to instrument for changes in the manufacturer price. Given this econometric approach, retail prices adjust almost exactly cent-for-cent with changes in manufacturer prices.

Table 9
Regression of changes in retail prices on changes in net manufacturer prices[1] (quarterly data)

Variable	Net retail prices
Δ Cost (t)	1.023
	(0.104)
Δ Cost (t-1)	0.024
	(0.128)
Constant	0.005
	(0.001)
Quarter dummies	Yes
Number of observations	3,247

Source: Authors' analysis of Nielsen retail price data, Promodata wholesale price data, and New York Board of Trade commodity price data.

[1]The dependent variable in these regressions is the change in the net retail price in a particular quarter.

Conclusion

Using the coffee industry as a model, this report demonstrates how changes in costs pass through into manufacturer and retail prices. We find that both retail and manufacturer coffee prices respond to costs slightly less than one-for-one (in absolute terms) with changes in commodity costs. Given the substantial fixed costs in coffee manufacturing, a 3-percent change in retail prices is likely to result from a 10-percent change in commodity prices. Since manufacturer prices adjust approximately one-for-one with commodity prices (rather than proportionally), the margin increases in percentage terms as costs fall. We do not find that coffee manufacturers take advantage of commodity-cost variation to raise prices. Coffee prices do not respond systematically more to commodity cost increases than to commodity cost decreases.

During periods of relative stability on the commodity market, manufacturer prices may not change at all for a year or more. In addition, price changes are highly synchronized both within brands and between brands. Coffee manufacturers announce many of the price adjustments involving a large number of brands and products.

These results, demonstrating the pricing patterns in one food category, may be applicable to similar manufacturer and retail markets as changing prices and/or costs move through the system to wholesalers and retailers. In particular, if an industry is subject to large fixed costs or markups, the percentage pass-through of costs may be extremely low.

This report focuses on documenting the response of prices to cost changes in the coffee industry, but how firms respond to cost changes may also be explained by demand and supply factors. Firms often maintain fixed prices for their products for long periods of time. This price rigidity may play an important role in pricing dynamics. A successful model of pricing in the U.S. coffee industry is therefore likely to include both standard demand-and-supply factors as well as some additional barriers to price adjustment that cause firms to make only infrequent adjustments to their prices.

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