AI SUMMARY:

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Central Thesis:
The article examines price rigidity in the banking industry, focusing on deposit interest rates, and investigates how rigidity varies across firms and markets. It uses a unique dataset to analyze both upward and downward price adjustments, addressing the unresolved issue of asymmetry in price changes. The study finds that price rigidity is greater in more concentrated markets and that deposit rates are more rigid when the stimulus for change is upward rather than downward.

Legal/Academic Issues Addressed:
- Price rigidity and its variation across firms and markets.
- Asymmetry between upward and downward price adjustments.
- The role of market structure and firm characteristics in price rigidity.

Methodologies/Data Sources:
- Multinomial logit estimation to model price-change decisions.
- Monthly observations of deposit rates from 398 banks in 132 local markets (1983â€“1986).
- Data from the Federal Reserve System's Monthly Survey of Selected Deposits and Other Accounts.
- Security rates measured by the three-month Treasury-bill rate.
- Market concentration measured using the Herfindahl index.

Findings/Analysis:
- Price rigidity is significantly greater in more concentrated markets.
- Deposit rates are more rigid for upward changes than for downward changes.
- Larger banks exhibit less price rigidity, suggesting lower adjustment costs or greater awareness of market conditions.
- The observed asymmetry in rigidity is consistent with models of customer reactions and adjustment costs.

Recommendations/Implications:
- None stated.

THE RIGIDITY OF PRICES: EVIDENCE FROM THE BANKING INDUSTRY

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The Rigidity of Prices: Evidence from the Banking Industry

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Studies ranging over the years from Gardiner Means (1935) to Dennis W. Carlton (1986) have found evidence of price rigidity in a variety of different industries. In this paper, we employ a data set that offers numerous advantages over those used previously to investigate how price rigidity varies across firms and markets. We also address the unresolved issue of asymmetry between upward and downward price changes and discuss alternative explanations for the results obtained.

Our examination focuses on the setting of deposit interest rates by banks. This choice of empirical setting offers a number of advantages over the typical interindustry study. First, the data employed are actual transactions prices (rather than list prices) and contain numerous observations of both nominal price increases and decreases. This allows for a more complete investigation of asymmetries in the adjustment of prices upward and downward. Second, banks operate under widely differing local market conditions, allowing for estimation of market structure effects without the confounding effects of interindustry differences. Most importantly, this choice allows us to exploit the fact that a bank's decision to change local deposit rates in response to exogenous changes in interest rates is analogous to the decisions by firms in general to change prices in response to exogenous changes in costs. Since interest rates are observable and vary substantially over time, while costs are generally unobservable and have little short-term variation, this application allows for a more detailed and structured examination of price rigidity than is achievable in other settings.

Our primary findings are that price rigidity is significantly greater in markets characterized by higher levels of concentration and that deposit rates are significantly more rigid when the stimulus for a change is upward rather than downward. The latter result is analogous to the finding of greater downward price rigidity in the more typical case in which prices are paid to the firm, rather than by the firm, and contrasts with the finding of no asymmetry recently reported by Carlton (1986). We discuss the consistency of these and other findings with possible alternative explanations of price rigidity.

I. The Decision To Change Price

Numerous explanations may be offered for the existence of price rigidity and for its variation across firms and over time. In this section, we borrow heavily from the recent work by Julio J. Rotemberg and Garth Saloner (1987) to develop a simple framework designed to address some of the more salient aspects of price rigidity in banking and to distinguish among some of the more prominent explanations for them. To this end, consider a bank that issues local deposits and other liabilities and employs the funds to make loans and purchase securities. Following Michael A. Klein (1971), the bank is presumed (because of product differentiation, chartering restrictions, etc.) to exercise some market power in setting prices for local deposits, other liabilities, and loans but is assumed to be too small relative to the securities market to influence the secu-

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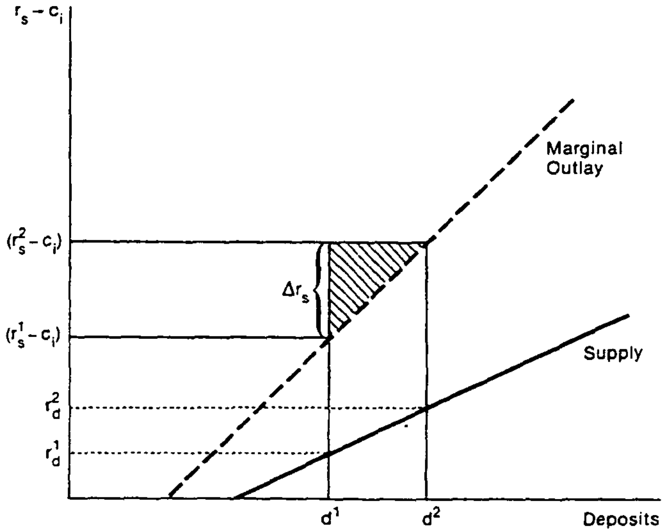

FIGURE 1. THE INCENTIVE TO CHANGE THE DEPOSIT RATE IN RESPONSE TO A CHANGE IN THE SECURITY RATE

rity rate.[1] We assume further that the security rate follows a random walk or martingale process, implying that future security-rate changes may be treated as unexpected.[2] We also assume that bank i is subject to a constant marginal noninterest cost c_i of transforming deposits into securities.

Under these assumptions, bank i's profit-maximizing deposit rate and the incentive to change the deposit rate in response to a change in the security rate are as depicted in Figure 1. The supply curve depicted represents bank i's perceived supply of deposits, as determined by the degree of product differentiation and conjectures of rival behavior. With an initial security rate of r_s^1, profits are maximized by offering a deposit rate r_d^1 (attracting deposits d^1), where the "marginal outlay" for deposits equals the marginal gain from using deposit funds to hold securities $(r_s^1 - c_i)$. An increase in the security rate from r_s^1 to r_s^2 implies an increase in the optimal deposit rate from r_d^1 to r_d^2, an increase in deposits from d^1 to d^2, and a potential gain represented by the shaded area in Figure 1. Assuming a linear supply of deposits to bank i, this gain may be shown to be $(1/4)b_i(\Delta r_s)^2$, where b_i is the inverse of the slope of the supply curve perceived by bank i and Δr_s is the change in the security rate (see Hannan and Berger, 1989). Whether or not the deposit rate is actually changed depends in

[1]This latter assumption is common in banking models and implies that the bank's marginal funding costs and marginal earnings on other financial assets are "pegged" to this rate. An alternative situation emphasized by Eugene F. Fama (1985) is one in which the marginal cost of funding is determined by the rate on large-denomination CD's. Assuming the CD rate to be invariant to the bank's behavior, the analysis would be similar, with the CD rate replacing the security rate.

[2]This assumption, which simplifies the analysis by eliminating the role of expected future changes in the security rate, is more plausible in this application than in any other of which we are aware. The reason is that the security rate readily falls as well as rises, while nominal costs typically move only upward as a result of inflation.

part on whatever cost must be incurred to change the price. Denoting this cost as F_i, it follows that bank i will change its deposit rate in response to a change in r_s if

$$(1) \qquad (1/4)b_i(\Delta r_s)^2 > F_i.$$

This incentive to change deposit rates may differ between upward and downward adjustments if, as discussed more fully below, b_i or F_i differs between price increases and decreases.[3]

It is clear from Figure 1 that bank i's marginal noninterest cost, c_i, plays the same role in the model as r_s and that replacement of c_i for r_s in (1) would yield the condition for a change in deposit rates induced by a change in marginal cost. In contrast to marginal costs, security rates are readily observable and may vary substantially in either direction in a relatively short time period. Thus, we focus on the role of security-rate changes in the following analysis.

Before proceeding, it is useful to note that at least two frequently modeled aspects of price rigidity are excluded by our simplifying assumptions. The assumption that security rates follow a random walk or martingale process, while tenable in this particular application, rules out the more complicated roles of expectations of future price changes considered by Steven G. Cecchetti (1986), Katuhito Iwai (1982), Eytan Sheshinki and Yoram Weiss (1983), and others. The assumed linearity of the model is also of significance, since a number of studies have drawn implications regarding the nature of price rigidity that depend on other functional forms (e.g., Timur Kuran, 1983) or on discontinuous demand or supply relationships stemming from the existence of distinct customer types (e.g., Lawrence M. Ausubel, 1991). Thus, we offer this analysis as a simplification that is designed to focus on some, but not all, potential determinants of price rigidity.

It follows from (1) that any bank or market characteristic associated with a larger value of b_i (implying a flatter supply of deposits in Fig. 1) will increase the incentive to change price. By demonstrating that b_i (as it applies to demand relations) is smaller for monopolists than for Bertrand duopolists, Rotemberg and Saloner (1987) employed this analysis to account for the previously unexplained phenomenon of greater price rigidity in monopolies relative to tight oligopolies. Here, we employ it to suggest the determinants of deposit-rate rigidity.

Two characteristics that may influence the slope of the perceived supply curve (and hence b_i) are the level of market concentration (CR) and the size of the firm's "customer base" in the market, defined as the deposits that would be supplied to bank i if all firms in the market were to offer the same rate. To the extent that firms in more concentrated markets exhibit higher price conjectures as a result of greater recognized interdependence, operation in a more concentrated market implies a lower value of b_i (i.e., a steeper perceived supply curve) and greater price rigidity.[4] To the extent that a larger customer base results in more customers changing deposit quantities in response to a price change, a larger customer base is likely to be associated with a higher value of b_i (i.e., a flatter perceived supply curve) and less price rigidity. Bank i's customer base in the market is measured as the product of the bank's share of the market's banking offices (MS_i) and the size of the market as measured by market income (I). Assuming for simplicity a linear relationship between b_i and its determinants,

$$(2) \qquad b_i = \alpha_1 + \alpha_2 CR + \alpha_3 MS_i I$$

[3]The gain and cost from changing price in equation (1) should be viewed as the present value of all current and future gains and costs associated with the change, respectively.

[4]Observed differences in local market concentration may be attributed either to regulatory factors, such as chartering or branching restrictions, or to the existence of local markets that are too small to support more than a few banks.

where $\alpha_1 > 0$, $\alpha_2 < 0$, and $\alpha_3 > 0$.[5] Substitution of (2) into (1) yields the condition for a price change as

$$(3) \qquad \beta_1(\Delta r_s)^2 + \beta_2(\Delta r_s)^2 \mathrm{CR} + \beta_3(\Delta r_s)^2 \mathrm{MS}_i I - F_i > 0$$

where $\beta_1 = (1/4)\alpha_1 > 0$, $\beta_2 = (1/4)\alpha_2 < 0$, and $\beta_3 = (1/4)\alpha_3 > 0$. Note that while the gain from a price change [represented by the first three terms in (3)] depends directly on size of the stimulus for the change $(\Delta r_s)^2$, firm and market characteristics operate only in interaction with this stimulus. Coefficient predictions imply that higher levels of concentration (CR) dampen the impact of a security-rate change, while a larger customer base ($\mathrm{MS}_i I$) enhances it.

Because of the macroeconomic significance of an inflationary bias in price adjustments (see Robert J. Gordon, 1981), past studies of price rigidity have looked for (and for the most part have failed to find) convincing evidence of asymmetry between price increases and decreases (see Arthur M. Okun, 1981; Carlton, 1986).[6] To address this question of asymmetric rigidity, we test for structural differences between price-increase and price-decrease decisions. Such differences may result for reasons that may be explained in terms of factors affecting the inverse slope of the perceived deposit supply curve (b_i) or the cost of adjusting prices (F_i). Consider first the possibility that price conjectures are greater for deposit-rate increases than for decreases—an assumption of the well-known kinked-demand (in this case kinked-supply) explanation of price rigidity. This implies that b_i is smaller for deposit-rate increases than for decreases and that the marginal outlay curve has an indeterminate region and a steeper slope for values of $r_s - c_i$ above this region than below it. This can be shown to imply symmetric price rigidity for smaller security-rate changes but rigidity that is greater upward than downward for larger changes. Thus, this hybrid explanation of price rigidity, in contrast to the traditional kinked-demand theory, is consistent with the observation of asymmetric price rigidity.

Other explanations of asymmetry rely on differences in the cost of adjusting prices (F_i) between upward and downward changes. One such explanation emphasized by Okun (1981) and Rotemberg (1982) maintains that negative customer reactions to unstable prices constitute a substantial part of the cost of a price change and that customers who value "dependable" pricing will react more negatively to unfavorable price changes than to favorable ones. This implies greater rigidity in the case of deposit-rate decreases. Another explanation maintains that rigidity results from collusive price arrangements that are more likely to break down if prices are changed. Since the expected costs of such breakdowns should be greater for deposit-rate increases than decreases, this implies greater rigidity in the case of rate increases. Still another explanation concerns the timing of consumer (depositor) reactions to price changes. To the extent that a lag exists between price changes and customer responses to them, this lag adds to the cost of a deposit-rate increase (as extra interest is paid before the full reaction of depositors is realized) and subtracts from the cost of a deposit-rate decrease. This implies greater rigidity for deposit-rate increases than for decreases. Because of the structural similarities, our analysis will not necessarily allow us to distinguish among all of these explanations.

[5]The prediction of $\alpha_1 > 0$ follows from nonnegativity of the slope of the perceived supply curve in the absence of concentration. A finite value of α_1 is guaranteed by the assumption of product differentiation. See Hannan and Berger (1989) for a detailed derivation.

[6]An exception is a related paper by David Neumark and Steven Sharpe (1991). Their analysis involves tracing the overall speed of adjustment of deposit rates over time, rather than examining observed price-change decisions (as in the current paper and in Carlton [1986]). They find that the speed of adjustment, which is influenced by the size of price changes as well as the likelihood of their occurrences, differs between price increases and decreases.

II. The Estimation Procedure

The addition to (3) of an error term assumed to have a logistic cumulative distribution allows estimation of the resulting probability condition using logit maximum likelihood. Since prices may increase, decrease, or remain unchanged, we employ a multinomial logit estimation procedure to estimate the following two relationships:

$$P_i^{\mathrm{up}}/P_i^{\mathrm{nc}} = \exp(\mathbf{x}_i'\boldsymbol{\beta}^{\mathrm{up}} + \varepsilon_i^{\mathrm{up}})$$

$$P_i^{\mathrm{dn}}/P_i^{\mathrm{nc}} = \exp(\mathbf{x}_i'\boldsymbol{\beta}^{\mathrm{dn}} + \varepsilon_i^{\mathrm{dn}})$$

where P_i^{up}, P_i^{dn}, and P_i^{nc} denote the probabilities that the deposit rate will increase, decrease, and not change, respectively; $\mathbf{x}_i$ denotes a vector of explanatory variables; $\boldsymbol{\beta}^{\mathrm{up}}$ and $\boldsymbol{\beta}^{\mathrm{dn}}$ denote coefficient vectors; and $\varepsilon_i^{\mathrm{up}}$ and $\varepsilon_i^{\mathrm{dn}}$ represent error terms.

Since it is the square of Δr_s that accounts for the effects of security-rate changes in (3), we distinguish between increases and decreases in Δr_s by multiplying $(\Delta r_s)^2$ by -1 in the case of a decrease. To avoid the confusion of different sign predictions in the price-increase and price-decrease equations, we then reverse the coefficient signs for all the terms containing $(\Delta r_s)^2$ in the price-decrease equation. As a result, the coefficients of the security-rate squared ($[\Delta r_s]^2$), its interaction with concentration ($[\Delta r_s]^2\mathrm{CR}$), and its interaction with the customer base ($[\Delta r_s]^2\mathrm{MS}_i I$) are predicted to be positive, negative, and positive, respectively, in *both* the price-increase and price-decrease equations. Intercept terms are predicted to be negative, reflecting the negative effects of price-change costs (F_t) on the likelihood of a price change. The natural log of bank assets, denoted $\ln A_i$, is also included in one estimation to account for the possibility that the costs of changing prices or other aspects of the price-change decision differ systematically with bank size.

III. The Data

The data consist of monthly observations of deposit rates offered by 398 banks located in 132 local banking markets and cover the period from September 1983 to December 1986. In all, the data include over 12,000 price-change decisions. The price examined is the rate on money-market deposit accounts (MMDA's) as reported in the Federal Reserve System's *Monthly Survey of Selected Deposits and Other Accounts*. These rates represent actual transaction prices paid during the week ending on the last Wednesday of the month. We focus on MMDA's because they have been shown to be competed for on a local basis and because their characteristics are relatively uniform across banks (see Berger and Hannan, 1989). Because the survey is conducted on a monthly basis, we must assume (as in all studies of price rigidity) that when a greater, lower, or same price is observed for a succeeding month, this implies that an increase, decrease, or no change, respectively, occurred during the period. Of the 12,179 observations, 2,471 involved price increases, 5,338 involved price decreases, and 4,370 involved no price change.

Security rates are measured by the three-month Treasury-bill rate. Consistent with the above analysis, Δr_s is measured as the difference between the current value of r_s and the value of r_s prevailing at the time of the last deposit-rate change. Thus, Δr_s measures how far "out of line" security rates have become since the last deposit-rate change. Concentration is measured by the market Herfindahl index, with markets defined as metropolitan statistical areas (MSA's; following previous research). Because of structural differences that may exist between banks located in urban and rural locations, the analysis excludes the relatively few banks not located in MSA's. To insure a close correspondence between observed rate-change decisions and market characteristics, banks with less than 75 percent of their deposits in one market are excluded from the sample.[7]

[7]Additional data sources are the Federal Deposit Insurance Corporation's *Summary of Deposits*, the Federal Reserve Board's *Reports of Condition and Income*, and the U.S. Department of Commerce's *Survey of Current Business*.

TABLE 1—MULTINOMIAL LOGIT ESTIMATIONS OF THE DECISION TO CHANGE DEPOSIT RATES

Explanatory variables	(1) Increase	(1) Decrease	(2) Increase	(2) Decrease
Constant	-0.63^{**}	-0.05^{*}	-1.93^{**}	-1.26^{**}
	(-24.09)	(-2.22)	(-10.43)	(-8.00)
$(\Delta r_s)^2$	2.31^{**}	3.19^{**}	2.36^{**}	3.26^{**}
	(9.85)	(10.74)	(10.08)	(10.87)
$(\Delta r_s)^2$CR	-9.06^{**}	-3.07	-8.66^{**}	-2.95
	(-7.48)	(-1.67)	(-7.22)	(-1.58)
$(\Delta r_s)^2 \mathrm{MS}_i I$	3.47^{**}	16.55^{**}	1.83	15.58^{**}
	(3.05)	(10.23)	(1.61)	(9.57)
$\ln A_i$			0.10^{**}	0.09^{**}
			(7.15)	(7.77)
Number of observations:	12,179		12,179	
$\ln \lambda$:	$2{,}490^{**}$		$2{,}570^{**}$	

Notes: The case of "no change" is included as the base (omitted) category; Δr_s is the change in the security rate since the last deposit rate change; CR is the Herfindahl index of market concentration; I is total market personal income; MS_i is the bank i's market share of bank branches; and $\ln A_i$ is the natural log of bank i's total assets. Asymptotic t statistics are in parentheses; $\ln \lambda$ denotes the log of the likelihood-ratio statistic.

*Statistically significant at the 5-percent level; **statistically significant at the 1-percent level.

IV. The Results

Table 1 presents the results of two multinomial logit estimations obtained with and without the inclusion of the log of bank assets ($\ln A_i$) to control for firm size. In both estimations, all intercept terms and coefficients have signs consistent with the underlying model, and in most cases they are highly significant. For both upward and downward price-change decisions, the intercept terms are significantly negative, while the coefficients of $(\Delta r_s)^2$ and the total derivatives of the price-change likelihoods with respect to $(\Delta r_s)^2$ (evaluated at sample means) are significantly positive. These results are consistent with the underlying premise that security-rate changes provide a stimulus for bank deposit-rate changes and that this stimulus must be sufficient to overcome the costs of a price change.

The negative coefficients of the interaction between the security-rate change and concentration, $(\Delta r_s)^2$CR, suggest that for a given change in the security rate, banks in more concentrated markets are less likely to change deposit rates. While this finding of greater price rigidity in more concentrated markets is not new (e.g., Carlton, 1986), we consider our results to be somewhat stronger than those reported previously because our analysis accounts for the stimulus for the price change (Δr_s), controls for other firm and market differences, avoids problems associated with interindustry differences, and distinguishes between price increases and decreases.

The positive coefficients of the interaction between the security-rate change and the customer base, $(\Delta r_s)^2 \mathrm{MS}_i I$, suggest less price rigidity on the part of firms with larger market customer bases—an implication of the "flatter" deposit supply curve presumably faced by such firms. The coefficients of bank size, $\ln A_i$, are positive and highly significant for both price increases and decreases. Possible explanations are that the costs (broadly defined) of changing prices are lower for larger firms or that larger firms are more aware of changing market conditions as a result of their closer orientations to wholesale funds markets.

Because of the large number of observations of price changes in both directions and the observability of the impetus for such changes, these data also offer significant advantages in investigating the issue of asymmetric price rigidity. Results presented in Table 1 suggest strongly that deposit rates are more rigid for increases than for decreases. Evaluated at sample means, estimation (1) yields a 62-percent probability that the bank will reduce its deposit rate in response to a decrease of 29 basis points in the security rate (the mean absolute change) and only a 39-percent probability that it will increase its deposit rate in response to the same-sized security-rate increase. The difference is statistically significant at the 1-percent level. The sources of this asymmetry may be seen by noting that the intercepts in each estimation are more negative for increases than for decreases (statistically different at the 1-percent level) and that the positive impact of security-rate changes on price-change likelihoods are less for deposit-rate increases than for decreases (statistically different at the 1-percent level).[8] Indeed, all coefficients of variables containing $(\Delta r_s)^2$ are algebraically greater (with equality rejected at the 5-percent level) for deposit-rate decreases than for increases, although differences in the case of the coefficients of $(\Delta r_s)^2$CR and $(\Delta r_s)^2 MS_i I$ are not robust with respect to some changes in sample selection and variable measurement.[9] From these results, it appears that the observed asymmetry is attributable to differences in items that do and do not interact with $(\Delta r_s)^2$.

Due in part to our finding of asymmetries in several parts of the model, it is difficult to distinguish among alternative explanations of asymmetric price rigidity. It does appear, however, that our results do not support explanations that focus on the role of negative customer reactions as a major cost of changing price, since such explanations are inconsistent with our finding of less rigidity for deposit-rate decreases. Our results are also inconsistent with the pure kinked-demand (supply) explanation of price rigidity, since this well-known analysis by itself does not imply asymmetric rigidity.

The robustness of these results with respect to numerous changes in variable measurement and sample selection was also examined. These changes include (i) lagging by one month the value of Δr_s, (ii) replacing $(\Delta r_s)^2$ with Δr_s in defining the explanatory variables, (iii) including savings and loans in the calculation of CR and MS_i, (iv) adding banks not located in MSA's to the sample, (v) testing for coefficient differences between banks located in states that prohibit branching and those that do not, (vi) accounting for differences in population densities, and (vii) employing total deposits and unlogged total assets as alternative measures of firm size. The finding that the coefficients of $(\Delta r_s)^2$CR and $(\Delta r_s)^2 MS_i I$ differ between price increases and decreases has been noted to be sensitive to some of these changes. However, the findings of (a) greater price rigidity exhibited by firms in more concentrated markets, (b) less price rigidity on the part of larger firms, and (c) asymmetric rigidity, with deposit rates more rigid upward than downward, were found to be insensitive to virtually all of these changes.[10]

V. Conclusion

This study has examined the setting of deposit interest rates by banks to investigate how price rigidity differs across firms and markets and between upward and downward price changes. We find that firms in more concentrated markets and smaller firms exhibit greater price rigidity, all else equal, and that deposit rates are significantly more rigid when the stimulus for a deposit-rate change is upward. This latter

[8]The impact of r_s, defined as the total derivative with respect to r_s, is less for deposit-rate increases for all values of CR and $MS_i I$ in the sample.

[9]Specifically, this difference for $(\Delta r_s)^2$CR is not found when more rural, non-MSA markets are included in the sample, and the reported difference for $(\Delta r_s)^2 MS_i I$ is not found when Δr_s is lagged by one month.

[10]An exception was the finding of no effect of firm size for banks located in the few states that prohibit branching.

finding is analogous to the finding of greater downward rigidity in the more typical case in which prices are paid to the firm, rather than by the firm, and contrasts sharply with the finding of no asymmetric rigidity reported in some previous research. We suspect that the advantages inherent in our data set, which contains numerous observations of price decreases as well as increases, accounts for this difference. Finally, our results allow us to distinguish among some, but not all, explanations of price rigidity. In particular, our findings are inconsistent with either negative customer reactions or the pure kinked-demand (supply) theory as the primary source of rigidity, since these explanations predict either no asymmetry or asymmetry opposite to the type found here.

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