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This paper provides an empirical investigation of how firms with cost advantages (cost disadvantages) exploit (cope with) their advantages (disadvantages) through their pricing behavior. Guided by microeconomic theory and insights from the industrial organization literature, we develop testable implications about the effect of industry structure and firm-specific characteristics on the pass-through elasticity: The rate at which changes in a firm's cost relative to competitors translates into changes in the firm's price relative to competitors. We test these implications using data from the PIMS Competitive Strategy database. The results indicate that a firm's pass-through elasticity systematically depends on whether the firm operates in a commodity or noncommodity industry, the firm's capacity utilization, and its cost and quality position in its industry. The pass-through elasticity is also shown to depend in a nonlinear way on market concentration.
(*Competitive Strategy; Competitive Advantage; Pricing; Cost Pass-Through*)

1. Introduction

This paper presents an empirical analysis of how firms exploit cost advantages or cope with cost disadvantages through pricing. In particular we ask: Do firms that experience favorable cost changes generally pass along most or all of their incremental advantage in the form of lower prices, profiting from the advantage through increased market share? or do they "bank" their advantage and profit from it primarily through increased price-cost margins? Similarly, do firms that experience unfavorable cost changes cope with them by translating their higher costs into higher prices, thereby preserving margins, or do they sacrifice margins by maintaining price parity with lower-cost firms and minimize the effects of their disadvantage by preserving market share? Does the manner in which a firm exploits its cost advantage or cope with its cost disadvantage vary systematically with either its market environment or with its existing competitive position at the time it experiences the cost change?

Given the importance of pricing in industrial organization and competitive advantage in strategic management, it is perhaps surprising that the issue of how firms exploit cost advantages and cope with cost disadvantages through pricing has received comparatively little attention in either field. In industrial organization, empirical work on pricing in the structure-conduct-performance (SCP) tradition focused on how differences in market conditions affected average price-cost margins across all firms (e.g., Koller and Weiss 1989), while research in the tradition of the new empirical industrial organization (NEIO) has typically focused on characterizing the nature of competitive interactions among firms (e.g., Porter 1983, Bresnahan 1987) or estimating demand elasticities from aggregate data in markets in which there is a rich unobservable microstructure of demand (e.g., Berry et al. 1995, Nevo 2001). Neither the work

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in the SCP or NEIO traditions has focused on how the pricing behavior of a firm varies as a function of its cost position in its industry and how industry structure and firm characteristics might systematically influence the mapping from cost position to price position.

In the strategic management literature, Porter's classic works *Competitive Strategy* (1980) and *Competitive Advantage* (1985) contain detailed discussions of cost leadership as a generic competitive strategy. Implicit in this discussion is the idea that a cost leader will exploit its advantage through lower prices in order to build volume. However, Porter does not discuss how the extent of this pass through should vary as a function of market or firm characteristics. The importance of cost advantage has also been evident in work on isolating mechanisms (Rumelt 1984), commitment and sustainability (Ghemawat 1991), and the resource-based view of the firm (Peteraf 1993). Yet, though this body of work offers economic-based theories for persistent heterogeneity and sustainable cost advantages, it does not address how firms should exploit their advantages, either through pricing or other competitive tactics.

Although these fields have not focused on the issue, managers in many industries have paid considerable attention to how cost advantages are exploited. For example, health-care managers and policy makers have been concerned about the practices of some low-cost providers and insurers who set prices just below their higher-cost competitors. Similar concerns arose in international trade when in the 1980s Asian firms apparently did not pass along the benefits of favorable exchange rates in the prices of exports.[1]

To understand how market structure and firm-level characteristic affect the way in which cost advantages and disadvantages are translated into pricing, this paper studies the behavior of the *pass-through elasticity*—the rate of percentage change in a firm's price *relative* to its competitors with respect to a percentage change in its marginal cost *relative* to competitors—across a broad cross-section of industries. Microeconomic theory generates two robust implications about the pass-through elasticity. First, in homogeneous product (i.e., commodity) industries, the pass-through elasticity should be zero, while in differentiated product industries, the pass-through elasticity will, in general, be positive. Second, in differentiated product industries, the pass-through elasticity should be smaller the greater the firm's capacity utilization.

Microeconomic theory is less definitive in predicting how a firm's initial competitive position—its market share, its relative quality position, and its relative cost position—should affect its pass-through behavior. Competitive position should matter, but theoretical predictions about the direction of the effects are ambiguous. Pass-through behavior should also be affected by the nature of competitive interactions between the firm and its competitors, although here, too, microeconomics is not definitive on the direction of the effect. There is reason to believe, however, that to the extent that firms in very tight oligopolies use constant-mark-up pricing as a rule of thumb to facilitate tacit collusion, these firms should have higher pass-through elasticities than firms in other market structures. As will be explained later, when each firm in a tight oligopoly strives to maintain a fixed price-cost margin (e.g., each firm sets its price 60% higher than its marginal cost no matter what its marginal cost is and no matter what its rivals' prices are), a given change in marginal cost will be fully passed through into relative price (e.g., a 10% increase in marginal cost will translate into a 10% increase in its price relative to its competitors).

To test these implications and to uncover other empirical regularities, we use data from the PIMS (Profit Impact of Market Strategy) Competitive Strategy database. The PIMS data set is well suited to explore how firms exploit competitive advantages because it contains data on the relative price and cost positions of a large sample of firms in many industries. Our econometric specification estimates the extent to which changes in a firm's unit costs relative to its competitors explain changes in its price relative to competitors, controlling for other factors, such as changes in relative product quality, that might also be expected to influence relative price changes. Variables such as market concentration and capacity

[1] In health care, this practice is known as "shadow pricing," and in international trade, it is known as "pricing to market."

utilization are interacted with changes in relative cost to test whether these characteristics have a significant impact on the pass-through elasticity.

The results from the empirical analysis support many of the implications just described. The two robust implications of microeconomic theory are confirmed: Commodity industries have significantly lower pass-through elasticities than noncommodity industries, and pass-through elasticities in noncommodity industries are a decreasing function of capacity utilization. Market concentration appears to have a nonlinear effect on pass-through behavior. Increased concentration has a weakly negative effect on pass through for firms in all but the most concentrated markets. Firms in the most highly concentrated markets have significantly higher pass-through elasticities than others. A firm's competitive position also has a significant impact on the pass-through elasticity. Firms with initial *cost* advantages have significantly smaller pass-through elasticities than firms with initial cost disadvantages, while firms with initial *quality* advantages have significantly greater pass-through elasticities than firms with quality disadvantages. Finally, we find that firms that simultaneously experience both a cost change and a quality change exploit the cost change differently than do firms that only experience the cost change (controlling for the direct effect of the quality change on price). This suggests that the source of a cost change—whether it is because of exogenous factors, such as factor prices, or endogenous factors such as changes in product quality—could affect how the firm responds to it.

The organization of the remainder of this paper is as follows: Section 2 discusses the economics of pass-through; §3 describes our empirical methods and data; §4 reports and interprets our empirical results; and §5 summarizes and concludes.

2. The Economics of Cost Pass Through

The way in which a firm exploits a cost advantage—or copes with a cost disadvantage—is reflected in the degree to which a change in the firm's relative cost position translates into changes in the firm's price relative to the prices of its competitors. This is measured by the pass-through elasticity.

$$\frac{\%\Delta P^{rel}}{\%\Delta MC^{rel}},$$

where $\%\Delta P^{rel}$ is the percentage change in a firm's price P relative to the average price $\overline{P}$ of its competitors, and $\%\Delta MC^{rel}$ is the percentage change in the firm's marginal cost relative to the average marginal cost of its competitors. This can be rewritten as:

$$\frac{\%\Delta P - \%\Delta \overline{P}}{\%\Delta MC^{rel}}. \tag{1}$$

That is, the pass-through elasticity depends on the *difference* between the percentage change in the firm's price and the percentage change in the average price of competitors.

In *commodity industries* (i.e., markets with homogeneous products, such as steel or coal), standard price theory implies that the pass-through elasticity should be zero. This is because in standard microeconomic models of commodity industries all firms charge a common industry equilibrium price. That common price might change when one firm's marginal cost goes down, but the firm's price *relative* to its competitors' prices would not. For example, in the standard Cournot model of oligopoly, a decrease in one firm's marginal cost (holding all other firms' marginal costs fixed) typically induces a decrease in the common industry price. However, the pass-through elasticity, as expressed in (1), would be zero because the firms' price relative to its competitors equals 1 before and after its marginal cost shifts. In homogeneous products markets, market structure characteristics (e.g., concentration) and firm-specific characteristics (e.g., capacity utilization or initial competitive position) would therefore not affect the pass-through elasticity.

In *noncommodity industries* (i.e., markets in which firms produce differentiated products), the pass-through elasticity is driven more by changes in the firm's own price ($\%\Delta P$) than by changes in competitors' prices ($\%\Delta \overline{P}$), and is therefore positive. How large it will be will generally depend on both market structure conditions and firm-specific characteristics.

To build intuition about the effect of market structure on the pass-through elasticity, note that the magnitude of the pass-through elasticity is determined by

the extent to which a shift in marginal cost induces a change in the firm's price-cost margin P/MC. If price-cost margins are "elastic," i.e., if they go down significantly when a firm's marginal cost shifts up or go up significantly when its marginal cost shifts down, the pass-through elasticity will be low. In such cases, a firm "eats" an upward shift in its marginal cost by shrinking its price-cost margins, and it "banks" a downward marginal cost shift by expanding its price-cost margin. In both cases, the firm's price changes by less than its cost does, pushing the pass-through elasticity downward. If, by contrast, "own" equilibrium price-cost margins are "sticky," i.e., if they remain virtually unchanged as a result of the cost shift, then a firm's price will change by about as much as its cost changes, and the pass-through elasticity will be large.

At first blush, it appears that microeconomic theory would offer few definitive predictions on how shifts in marginal cost affect equilibrium price-cost margins. Standard price theory reasoning implies that while the *level* of a firm's equilibrium price-cost margin is determined by the *level* of its perceived price elasticity of demand, a *change* in its equilibrium price-cost margin induced by a shift in marginal cost is determined by how the firm's price elasticity of demand *changes* along its demand curve. It is unclear a priori how structural factors, such as market concentration or barriers to entry, would systematically affect the "elasticity of the elasticity" and thus the pass-through rate.[2]

There is, however, an older tradition in industrial organization that might provide a basis for generating one potential empirical implication. It is sometimes argued that one way for firms to facilitate pricing coordination in oligopolistic markets is to employ a standard industrywide markup over cost to determine the product price.[3] To the extent that such rules are employed (and there is an older empirical literature that suggests they are[4]), a firm in a tight oligopoly would be expected to maintain a constant price-cost margin as its costs shift up or down. That is, firms' price-cost margins would be "sticky," implying (as discussed above) large pass-through elasticities. This suggests one testable implication: The pass-through elasticity should tend to be especially large for firms that operate in tight oligopolies.

A second key driver of the pass-through elasticity in noncommodity markets is the rate at which marginal costs rise with output. Price theory offers an unambiguous prediction on this point: The more rapidly marginal costs rise with output in a neighborhood of the firm's initial equilibrium, the lower will be its pass-through elasticity.[5] Figure 1 illustrates this result. If the firm operates in the region where its marginal cost curve rises rapidly (think of the firm operating close to full capacity), a given shift in its marginal cost function (up or down) will have relatively little impact on the firm's pricing decision: Price continues, in effect, to be determined by the firm's capacity constraint. This suggests another testable empirical implication: The pass-through elasticity should be a decreasing function of capacity utilization.

The pass-through elasticity is also likely to depend on the firm's initial competitive position, as measured

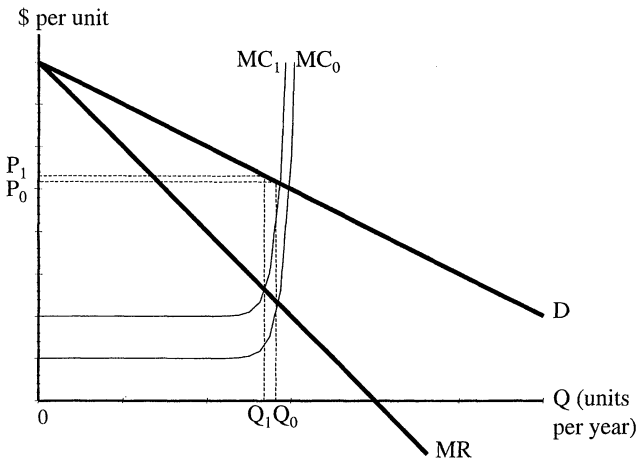
[2] This point is emphasized in the international trade literature on exchange rate pass-through. See Marston (1990).

[3] See Scherer and Ross (1990, 261–264) for an extended discussion of the logic of rule-of-thumb pricing as a facilitating condition.

[4] Scherer and Ross (1990) provide a detailed review of this literature.

[5] This result holds for a wide range of conduct patterns, including Bertrand price setting, Cournot quantity setting, and collusion and for a wide range of plausible demand specifications.

Figure 1 Rising Marginal Cost and Pass-Through



by its initial quality position relative to competitors, its initial cost position, and its initial market share. However, neoclassical price theory does not provide an unambiguous prediction about the directions of these effects. For example, Feenstra et al. (1996) present a price-theoretic analysis that suggests that the effect of market share on the pass-through elasticity should, in general, be ambiguous. Their empirical evidence from the automobile industry indicates that market share affects the pass-through elasticity, but in a nonmonotonic fashion. In summary, then, we hypothesize that initial competitive position should affect the pass-through elasticity, but we remain agnostic on the direction of possible effects. Since economics offers no clean hypotheses that would be expected to apply across a large cross-section of industries, our goal in this part of the study is simply to uncover interesting empirical regularities.

The above discussion pertains to the economics of pass-through for firms that experience exogenous cost shifts. However, firms might also experience a change in marginal cost because they have changed product quality or altered product performance. For such firms, relative price could change because of both the cost change and the shift in demand due to the quality change. To account for this possibility, the empirical analysis below includes a change in a firm's relative product quality as a predictor of the change in the firm's relative price. This nets out that portion of the change in relative price that results from quality changes. A related but more subtle point is that a firm might exploit a cost change differently depending on whether the change arises from exogenous factors, such as factor price increases, or from endogenous changes in product attributes. Our data cannot tell us why firms' relative costs changed, but one way to get at the issue of whether the origin of the cost change influences how firms react to it is to test whether firms that simultaneously experience cost and quality changes exhibit different pass-through elasticities from firms that only experience changes in relative costs. We will do this in the empirical work described below.

To summarize, formal microeconomic analysis gives us two unambiguous empirical implications:

- The pass-through elasticity in commodity markets should be significantly lower than it is in noncommodity markets.
- In noncommodity markets, the pass-through elasticity should be lower the closer the firm is to full capacity utilization.

Formal theory provides no clean implications about the impact of market concentration on pass-through in noncommodity markets. However, traditional industrial organization suggests that in noncommodity markets, the pass-through elasticity should be high when firms interact as a tight oligopoly. Finally, we conjecture that the pass-through elasticity will depend on initial market share, initial cost position, initial quality position, and the change in its relative quality position. The direction of these effects is, however, a priori ambiguous.

The next section describes how we test these implications.

3. Empirical Methods

3.1. Econometric Methodology

We analyze the empirical behavior of pass-through elasticities across a broad spectrum of industries using data from PIMS (Profit Impact of Market Strategy). A firm in the PIMS database reports its prices, direct costs (costs of materials, labor, and distribution), and various measures of product quality *relative* to its three largest direct competitors. The empirical model examines the determinants of *changes* in relative prices, effectively removing firm-level cross-section effects. The basis specification is as follows:

$$\begin{aligned}\Delta P_{it}^{rel} = {} & \xi_0 + \xi_1 \Delta MC_{it}^{rel} + \xi_2 \Delta Q_{it}^{rel} \\ & + \xi_3(\Delta MC_{it}^{rel} \times S_{it}) + \xi_4(\Delta MC_{it}^{rel} \times F_{it}) \\ & + \xi_5 IND + \xi_6 YEAR + \omega_{it}, \end{aligned} \tag{2}$$

where

ΔP_{it}^{rel} = % change in firm i's relative price across time period t.
ΔMC_{it}^{rel} = % change in firm i's relative direct cost per unit across time period t.
ΔQ_{it}^{rel} = % change in firm i's relative product quality across time period t.

S_{it} = industry-specific interaction variables (e.g., market concentration) that influence the degree to which firms pass along cost changes.
F_{it} = firm-specific interaction variables (e.g., capacity utilization) that influence the degree to which firms pass along cost changes.
IND = fixed effects for industry (two-digit SIC (Standard Industrial Classification) code).
$YEAR$ = fixed effects for year.
ω_{it} = a random disturbance.

Although the empirical model will generate an estimate of an "average" pass-through elasticity, our interest is not so much in the level of the pass-through elasticity itself, but in the extent to which there are systematic relationships between the level of pass-through elasticity and industry structure and firm-specific variables. The interaction variables S_{it}, F_{it} are included to explore this question.[6] A complete description of each variable used in the empirical analysis appears in the next section.

PIMS censors about 1% of the values of P^{rel}. Thus, we initially estimate (2) using Tobit regressions. However, least squares regression, and variants such as Tobit, are not really appropriate for estimating Equation (2) with the data in hand. One reason is that over 43% of all firms report $\Delta P^{rel} = 0$, including 35% of those firms for which $\Delta MC^{rel} \neq 0$ or $\Delta Q^{rel} \neq 0$. Moreover, the vast majority of the remaining firms report relative price changes in 5% increments. These facts imply that it is unlikely that ω is normally distributed. It is also unlikely, given the survey nature of the PIMS data and the fact that what is being reported is a change in a firm's price *relative* to its competitors, that reported price changes are precise.

The preponderance of zero values of ΔP^{rel}, combined with the observation that the reported price changes are probably imprecise estimates, suggests that it would be reasonable to rescale ΔP^{rel} as an ordinal variable. To do this, we compute a categorical variable R which ranges in value as follows:[7]

$$R = \begin{cases} 1 & \text{if } \Delta P^{rel} \leq -30 \\ 2 & \text{if } \Delta P^{rel} \in (-30, -15] \\ 3 & \text{if } \Delta P^{rel} \in (-15, -2] \\ 4 & \text{if } \Delta P^{rel} \in (-2, 2) \end{cases},$$

$$R = \begin{cases} 5 & \text{if } \Delta P^{rel} \in [2, 15) \\ 6 & \text{if } \Delta P^{rel} \in (15, 30] \\ 7 & \text{if } \Delta P^{rel} \geq 30 \end{cases}.$$

We estimate the model in (2) with R as the dependent variable using an ordered probit model. In ordered probit estimation, the observed category is conditional on the independent variables in the model. Specifically, if X denotes the independent variables of the regression model, ξ a vector of coefficients, and a vector ϕ of parameters to be estimated, then

$$R = 1 \quad \text{if } \xi X \in (\phi_0, \phi_1],$$
$$R = 2 \quad \text{if } \xi X \in (\phi_1, \phi_2],$$

and so forth. Let the cumulative normal distribution be denoted by $F(\cdot)$, and let $\phi_0 = -\infty$ and $\phi_7 = \infty$. Then the probability of a firm falling into category k is given by $Pr(R_k) = F(\phi_k - \xi X) - F(\phi_{k-1} - \xi X)$. Maximum likelihood estimation yields the coefficient vector ξ and the parameters ϕ.

3.2. Data

The data for this study come from the PIMS Competitive Strategy (SPI4) database. SPI4 provides data in 4-year blocks for a cross-section of business units across many industries.[8,9] Our variables are listed

[6] The particular S_{it} and F_{it} variables used in the analysis are both numerical and dummy variables. The specific industry and firm interaction variables are discussed below.

[7] In the PIMS data, values of P^{rel} are obtained by multiplying the ratio of prices by 100. Thus, $\Delta P^{rel} = 20$ would, for example, correspond to a situation where one firm's price changed from being equal to its competitors prices to a situation where it was 20 percent higher than its competitors' prices.

[8] An observation in SPI4 is thus a particular business unit over a particular four-year horizon. A given business unit might be represented once or more than once in SPI4, depending on how long participated in the PIMS survey.

[9] Firms in the PIMS database come from both manufacturing and retail and wholesale distribution. The large majority of business units in the database, however, are from manufacturing industries.

and defined below. Note that for the principal study variables (price, cost, quality), we used the average annual change over the 4-year block rather than the level of that variable at any point during the period.

- %Δ*RELPRICE*: Average annual percentage change in price relative to competitors (averaged over the 4-year period).
- %Δ*RELCOST*: Average annual percentage change in direct costs per unit relative to competitors (averaged over the 4-year period). Direct costs are defined as the costs of labor, materials, and distribution, and thus provide the closest approximation to marginal cost available in the PIMS database. Direct costs *do not* include marketing and administrative costs. The magnitude of the impact of relative cost on relative price indicates the magnitude of the pass-through elasticity for the firm.
- *RELCOST–UP*: A dummy variable that takes on a value of 1 when relative cost goes up. This variable is included in the analysis to test whether the pass-through elasticity differs depending on whether relative costs go up or down.
- %Δ*RELQUAL*: Average annual percentage change in product quality relative to competitors (averaged over the 4-year period). The quality measure is a subjective scale described in detail in Buzzell and Gale (1987). Changes in relative quality would be expected to increase relative price, irrespective of changes in relative cost. In addition, an interaction between %Δ*RELQUAL* × %Δ*RELCOST* is included to test whether the pass-through elasticity varies systematically between firms that also experienced a change in relative quality and those that did not.
- 4*CR*: The 4-firm concentration ratio in the firm's "PIMS market." The PIMS survey asks respondents to define their markets narrowly.[10] Thus, a PIMS market corresponds to what economists would think of as a submarket or a market segment or what a strategist might think of as a strategic group. Accordingly, PIMS markets are typically much more concentrated than the firm's 4-digit SIC industry.[11] An interaction, 4*CR* × %Δ*RELCOST* is included to test the impact of market concentration on the pass-through elasticity.
- *TIGHTOLIGOP*: A dummy variable equal to one if the 4-firm concentration ratio equals 100%.[12] An interaction *TIGHTOLIGOP* × %Δ*RELCOST* is included as an alternative way to test whether market concentration has an impact on the pass-through elasticity, focusing on whether the pass-through elasticity differs systematically between firms that are in tight oligopolies and those that are not.
- *CAPUTIL*: The percent capacity utilization of the business unit at the beginning of the 4-year horizon. We scale this so that if reported capacity utilization is below 70 percent, *CAPUTIL* equals 0, and if it is above 70%, *CAPUTIL* equals reported capacity utilization minus 70. An interaction, *CAPUTIL* × %Δ*RELCOST* is included to test the impact of capacity utilization on the pass-through elasticity. Because higher values of beginning-period capacity utilization could also result in increases in relative price independent of changes in relative cost position, *CAPUTIL* is also included in noninteracted form.
- *EXIT*: A zero-one variable indicating whether a major competitor has exited within the 4-year period. *EXIT* is included as a control variable in the analysis. It could indicate one of two things. First, the exit of a major competitor will cause market concentration to rise which could alter the relative prices of remaining firms. In addition, the exit of a major competitor could also indicate that the firm has a cost or a quality advantage that has recently become more pronounced. This could also lead to a change in the firm's relative price. In general, the coefficient of *EXIT* could be positive or negative.
- *RELQUAL, SHARE, RELCOST*: the firm's relative quality, market share, and relative cost in the base year. Interactions *RELQUAL* × %Δ*RELCOST*, *SHARE* × %Δ*RELCOST*, *RELCOST* × %Δ*RELCOST* are included to test whether initial competitive position has an impact on the pass-through elasticity.
- *COMMOD*: We classified industries into two groups: commodity industries and noncommodity

[10] See Buzzell and Gale (1987) for an extended discussion of the PIMS notion of market definition.

[11] We also used the 4-firm concentration ratio in the firm's 4-digit SIC industry. We discuss these results below.

[12] Our findings do not change if we use a lower cutoff, such as 90%. Approximately 11% of the firms in our samples operated in markets with a 4-firm concentration ratio of 100%.

industries. The following (2-digit SIC) industries were classified as commodity industries (*COMMOD* = 1): paper and allied products (SIC 26); chemicals and allied products (SIC 28); petroleum and coal products (SIC 29); rubber and plastics products (SIC 30); and stone, clay, and glass products (SIC 32). The following industries were classified as noncommodity industries (*COMMOD* = 0): food and kindred products (SIC 20); textile mills products (SIC 22); furniture and fixtures (SIC 25); printing and publishing (SIC 27); fabricated metal products (SIC 34); industrial machinery and equipment (SIC 35); electronic and other electric equipment (SIC 36); transportation equipment (SIC 37); and instruments and related products (SIC 38). *COMMOD* is interacted with $\%\Delta RELCOST$ to test whether, as predicted by theory, the pass-through elasticity is systematically lower in homogeneous products industries than in differentiated products industries.

We started with a total of 8,005 observations of business units in discrete four-year blocks. We restricted our attention to those 5,629 observations for which *RELCOST* does not equal zero, because all of our key hypotheses examine the effect of *RELCOST* (or variables interacted with *RELCOST*) on *RELPRICE*. However, our findings are virtually unchanged when we examine the full data set. We further restrict our analysis to those 4,506 observations that report *4CR*. Finally, we are only able to categorize 3,297 observations as belonging definitively to commodity or non-commodity industries. These 3,297 observations constitute our final sample.

Table 1 reports summary statistics for the level values of each variable.

3.3. Econometric Caveats

Because PIMS data on price, cost, and product quality are subjectively reported and subject to idiosyncratic interpretations, an important concern in interpreting the empirical findings reported below is the possibility of omitted variable bias caused by unmeasured product attributes that simultaneously increase the desirability of the product while increasing costs. For example, a firm may incur a cost to improve the quality or reliability of its product and simultaneously raise price to reflect that improvement. If the firm does not report the improvement as an increase in quality in the PIMS survey, then the simultaneous increase in price and cost will cause us to overestimate the magnitude of the pass-through elasticity. We have two responses to this. First, the magnitude of the pass-through elasticities that we report below seem plausible and are in line with the pass-through elasticities estimated in a study by Ashenfelter et al. (1998) of the office superstore market. Second, our primary concern in this study is not to estimate pass-through elasticities per se but to determine the extent to which these elasticities vary with industry and firm characteristics, as indicated by the interaction terms discussed above. While the omitted variables problem could bias the magnitude of the pass-through elasticity, it imparts no obvious bias to the interaction terms that are of direct interest.

Another concern relates to the measure of cost change used in the analysis. Changes in direct costs most closely approximate the economist's notion of short-run marginal cost. However, a company might make a fixed investment (e.g., modernization of a plant or capacity expansion) that decreases its short-run marginal costs but increases its implicit capital costs. If the firm sets its price according to the change in long-run costs (short-run marginal cost plus capital costs) rather than just the change in short-run costs—

Table 1 Summary Statistics

Variable	Mean	Standard Deviation
$\%\Delta RELPRICE$: Percent change in relative price	1.98	15.3
$\%\Delta RELCOST$: Percent change in relative direct cost per unit	0.130	13.4
$\%\Delta RELQUAL$: Percent change in relative quality	0.33	3.90
4CR: 4-firm concentration ratio	73.7	21.6
CAPUTIL: Adjusted capacity utilization	10.2	10.7
RELCOST: Initial cost position	2.41	7.80
RELQUAL: Initial quality position	4.58	22.4
SHARE: Initial market share	24.2	19.2

a possibility that seems especially likely if the fixed assets depreciate within the 4-year PIMS window—then our empirical analysis will be subject to an errors in variables problem which will bias our estimate of the pass-through elasticity downward. There is no simple way to deal with this problem—the PIMS database does not, for example, include good measures of capital costs. However, in the analysis below it is at least reassuring that the pass-through elasticity is significantly greater than zero in the full sample of firms, and is especially significant for firms in non-commodity industries.[13]

Still another concern is that PIMS data might be biased due to self-selection and subjectivity and that this bias might be driving some, or even most, of our results. Participation in PIMS is voluntary, so it is not clear that representative PIMS participants are of a broader population of firms and business units. Marshall and Buzzell (1990) suggest that large and successful firms ("market leaders") are overrepresented in the PIMS database, as are firms that are more sophisticated in their approach to strategic decision making. This would be a problem if market leaders exhibited systematically different pass-through relationships from nonleaders, above and beyond the differentials that are already explained by the competitive positioning variables (cost advantage, quality advantage, market share) that are included in the analysis. While we cannot dismiss the possibility of such biases, it is difficult to deduce what their net effect might be.

PIMS data may also be biased due to their subjectivity. Since the data on certain variables depend on the subjective assessments of respondents, such biases as the overstatement of performance or the understatement of market scope are possible. That responding firms pay to participate in PIMS, however, may have the positive effect of providing an incentive to respond to the questionnaire as accurately as possible, especially since respondents receive PIMS data for their internal use and expect that their confidentiality will be maintained. It is difficult to determine the nature and extent of the biases in PIMS, however, since respondent confidentiality is strictly maintained.

Marshall and Buzzell (1990) investigated the potential impact of PIMS reporting biases by comparing the PIMS and Federal Trade Commission (FTC) line-of-business databases in terms of their descriptive properties and their relative success in predicting business unit performance. They found that while the PIMS and FTC databases differed in their limitations and idiosyncrasies, they produced very similar results, both descriptively and in their success in predicting firm profitability. While our study is very different from the traditional PIMS research whose robustness Marshall and Buzzell was investigating, Marshall and Buzzell's study provides some reassurance that use of PIMS is not significantly flawed by defects in the database.

4. Empirical Results

Tables 2 and 3 present the results of the Tobit and ordered probit regressions, and Table 4 provides a qualitative overview of the main results. Based on likelihood ratio tests, we can reject the hypothesis that changes in the left-hand-side variable were the same for all industry groups and in all time periods. Hence, we only report results when we include fixed industry and year effects. We cannot reject the hypothesis that 4*CR*, *RELQUAL*, *RELCOST*, and *SHARE* have no effect on the change in relative price, except when they are interacted with %*RELCOST*. Thus, we omit the noninteracted values of these variables from our reported regressions.

Because the results from the Tobit and ordered probit models are strongly consistent and because it is easier to interpret the Tobit coefficients, we focus our discussion on the results in Table 2. We computed several goodness of fit measures. We report adjusted R^2 for the OLS-equivalents of the Tobits. Since fewer than 1% of the left-hand-side variables are censored, this provides a good indication of fit. Adjusted R^2 ranges from 0.10 to 0.14, suggesting a modest fit. To assess goodness of fit for the ordered probits, we computed a "prediction success rate" for those firms reporting relative price changes larger than 15%. We used the coefficients from the ordered probits to compute the

[13] Moreover, if anything, our estimated pass-through elasticities seem somewhat larger than those in the aforementioned study by Ashenfelter et al. (1998).

Table 2 Results: Tobit Models

Variable	Model 1	Model 2*	Model 3*	Model 4*	Model 5*
%ΔRELCOST	0.238[a]	0.239[a]	0.283[a]	0.340[a]	0.446[a]
RELCOST–UP × *%ΔRELCOST*	−0.064	–	–	–	–
%ΔRELQUAL	0.390[a]	0.464[a]	0.457[a]	0.454[a]	0.307[a]
EXIT	3.76[a]	3.80[a]	3.81[a]	3.83[a]	3.91[a]
CAPUTIL	0.062[b]	0.053	0.052	0.057	0.052
CAPUTIL × *%ΔRELCOST*	−0.0062[a]	−0.011[a]	−0.010[a]	−0.011[a]	−0.013[a]
COMMOD × *%ΔRELCOST*	−0.143[a]	–	–	–	–
4CR × *%ΔRELCOST*	0.0028[a]	0.0011	0.0001	−0.0005	−0.0019
TIGHTOLIGOP × *%ΔRELCOST*	–	–	0.158[c]	0.150[c]	0.220[b]
RELCOST × *%ΔRELCOST*	0.0029	0.0066[a]	0.0069[a]	0.0074[a]	0.0090[a]
RELQUAL × *%ΔRELCOST*	0.0044[a]	0.0066[a]	0.0061[a]	0.0036[a]	0.011[a]
SHARE × *%ΔRELCOST*	−0.0035[a]	−0.0003	0.0000	0.0005	−0.0020
%ΔRELQUAL × *%ΔRELCOST*	–	–	–	−0.024[a]	−0.017[a]
RELCOST × *RELCOST–UP* × *%ΔRELCOST*	–	–	–	–	−0.0019
RELQUAL × *RELCOST–UP* × *%ΔRELCOST*	–	–	–	–	−0.0153[a]
SHARE × *RELCOST–UP* × *%ΔRELCOST*	–	–	–	–	0.0056[a]
Industry fixed effects	Included	Included	Included	Included	Included
Year fixed effects	Included	Included	Included	Included	Included
Constant	0.269	0.232	0.230	0.078	0.389
N	3297	1926	1926	1926	1926
R^2 (OLS equivalent)	0.10	0.13	0.13	0.14	0.14

*Noncommodity industries only.
[a]Significant at $p < 0.01$.
[b]Significant at $p < 0.05$.
[c]Significant at $p < 0.10$.

predicted probability that a firm with an actual relative price increase or decrease exceeding 15% would have changed its relative prices in the same direction. We compare this prediction score with the prediction score one would obtain from random chance. The latter simply equals the fraction of firms whose relative prices actually increased or decreased. The predicted probability of a relative price decrease for firms that actually lowered relative price was 0.33. The fraction that actually experienced lower relative prices was 0.21. The predicted probability of a relative price increase for firms with actual relative price increases exceeding 15% was 0.41. The fraction of firms that actually experienced an increase in relative price was 0.32. Thus, the ordered probit model adds modestly to our ability to predict whether firms increased or decreased relative prices.

Turning to the results, consider first the baseline model, Model 1, that includes the main key predictors. This model allows the pass-through elasticity to vary between commodity and noncommodity industries and according to whether the firm's relative cost goes up or down. In the baseline model, a change in a firm's relative quality has a significantly positive impact on the change in relative price: A 10% increase in relative quality translates into a 3.9% increase in relative price. The change in relative cost has a strongly significant impact on the change in relative price in noncommodity industries and a significantly smaller impact on the change in relative price in commodity industries, consistent with our expectations. Basing our calculations on a firm with average values for market concentration and the firm-specific variables, we find a pass-through elasticity of about 0.34 for a firm in a noncommodity industry and a pass-through elasticity of 0.17 for a firm in a commodity industry. More generally, we reject the hypothesis that there is a common pass-through model for commodity and noncommodity industries.

The insignificant coefficient of *RELCOST–UP* in the baseline model indicates that the pass-through elasticity for firms that experience an increase in relative

Table 3 Results: Ordered Probit Models

Variable	Model 1	Model 2*	Model 3*	Model 4*	Model 5*
%ΔRELCOST	0.019[a]	0.017[a]	0.020[a]	0.024[a]	0.030[a]
RELCOST–UP × *%ΔRELCOST*	−0.002	–	–	–	–
%ΔRELQUAL	0.026[a]	0.029[a]	0.029[a]	0.029[a]	0.020[a]
EXIT	0.265[a]	0.235[a]	0.237[a]	0.238[a]	0.245[a]
CAPUTIL	0.006[a]	0.005[b]	0.005[b]	0.005[b]	0.005[b]
CAPUTIL × *%ΔRELCOST*	−0.0004[a]	−0.0007[a]	−0.0006[a]	−0.0007[a]	−0.0008[a]
COMMOD × *%ΔRELCOST*	−0.0066[a]	–	–	–	–
4CR × *%ΔRELCOST*	0.0001	0.0000	0.0000	−0.0001	−0.0002[c]
TIGHTOLIGOP × *%ΔRELCOST*	–	–	0.010[c]	0.009	0.013[b]
RELCOST × *%ΔRELCOST*	0.0002	0.0004[b]	0.0004[b]	0.0004[a]	0.0005[a]
RELQUAL × *%ΔRELCOST*	0.0002[a]	0.0003[a]	0.0003[a]	0.0002[a]	0.0006[a]
SHARE × *%ΔRELCOST*	−0.0001[a]	0.0000	0.0001	0.0001	−0.0001
%ΔRELQUAL × *%ΔRELCOST*	–	–	–	−0.0017[a]	−0.0012[a]
RELCOST × *RELCOST–UP* × *%ΔRELCOST*	–	–	–	–	−0.0001
RELQUAL × *RELCOST–UP* × *%ΔRELCOST*	–	–	–	–	−0.0010[a]
SHARE × *RELCOST–UP* × *%ΔRELCOST*	–	–	–	–	0.0004[a]
Industry fixed effects	Included	Included	Included	Included	Included
Year fixed effects	Included	Included	Included	Included	Included
N	3309	1936	1936	1936	1936
Ordered Probit Cutoffs	−1.64	−1.59	−1.59	−1.59	−1.63
	−1.15	−1.09	−1.08	−1.08	−1.10
	−0.64	−0.56	−0.56	−0.55	−0.57
	0.65	0.57	0.57	0.58	0.57
	1.39	1.28	1.28	1.29	1.29
	1.87	1.79	1.80	1.82	1.81

*Noncommodity industries only.
[a]Significant at $p < 0.01$.
[b]Significant at $p < 0.05$.
[c]Significant at $p < 0.10$.

costs *does not* differ significantly from that for firms that experience a decrease in relative costs. Thus, we cannot reject the hypothesis that pass-through behavior is symmetric for the average firm that experiences a relative cost increase and the average firm that experiences a relative cost decrease. The positive coefficients on *CAPUTIL* and *EXIT* indicate that, independent of change in relative cost, a firm that has high-capacity utilization or has recently seen a major competitor exit the market is more likely to experience an increase in relative price.

The remaining models in Tables 2 and 3 pertain exclusively to firms in noncommodity industries. The coefficient on *CAPUTIL* × *%ΔRELCOST* is negative and highly significant. This indicates that a high rate of capacity utilization reduces the pass-through elasticity. The prediction that steeply rising marginal cost decreases the pass-through elasticity is perhaps the most robust implication about pass-through behavior that comes out of a comparative statics analysis of a wide class of oligopoly models, so it is reassuring to see this prediction borne out in the data.[14]

[14] Although not reported in Tables 2 and 3, the effect of capacity utilization on pass-through is symmetric: High rates of capacity utilization significantly reduce the pass-through elasticity for firms that experienced both increases and decreases in relative costs.

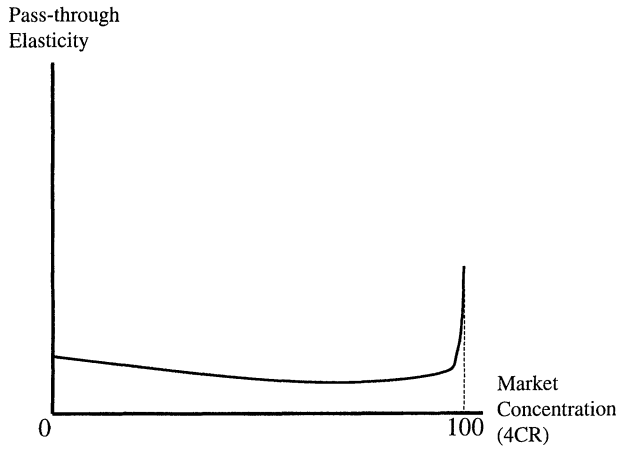
Table 4 Summary of Empirical Results

Variable	Predicted Effect	Rationale for Effect or Inclusion in Analysis	Estimated Effect
%Δ*RELCOST*	Nonnegative, but smaller in commodity industries	Basic pass-through relationship: relative price cannot go down when cost increases	0.17 commodity 0.34 noncommodity; significantly different
RELCOST–UP × %Δ*RELCOST*	Ambiguous	Test for asymmetric pass-through	Insignificant
%Δ*RELQUAL*	Positive	Relative price goes up when relative quality increases	Positive and significant
EXIT	Ambiguous	Control for changes in industry structure	Positive and significant
CAPUTIL	Ambiguous	Control for initial capacity utilization	Positive and significant
CAPUTIL × %Δ*RELCOST*	Negative	Pass-through becomes smaller as firm approaches full capacity	Negative and significant
4*CR* × %Δ*RELCOST*	Ambiguous	Microtheory has no definitive implications for how concentration should affect pass-through	Negative and significant in one model (Model 5); insignificant in others
TIGHTOLIGOP × %Δ*RELCOST*	Positive	Pass-through is large in tight oligopolies	Positive and significant
RELCOST × %Δ*RELCOST*	Ambiguous	Test for how initial competitive position affects pass-through	Positive and significant
RELQUAL × %Δ*RELCOST*	Ambiguous		Positive and significant
SHARE × %Δ*RELCOST*	Ambiguous		Insignificant
%Δ*RELQUAL* × %Δ*RELCOST*	Ambiguous	Test for whether cost pass-through differs if quality also changes	Negative and significant

The results with respect to market concentration are somewhat more complex. In Model 2, the coefficient on 4*CR* × %Δ*RELCOST* is positive but insignificant: Concentration does not seem to have a significant impact on pass-through behavior in noncommodity industries. However, when we include the coefficient on *TIGHTOLIGOP* × %Δ*RELCOST* in Models 3, 4, and 5, its coefficient is positive and significant. Thus, a firm's pass-through elasticity goes up significantly when it operates in a tight oligopoly. For all other firms, concentration seems to have a mildly negative effect on the pass-through elasticity: the coefficient on 4*CR* × %Δ*RELCOST* is negative but insignificant in Models 4 and 5 in the Tobit estimation and models in the probit estimation. It is negative and significant in Model 5 for the probit estimation.[15] Overall, then, the relationship between market concentration and the pass-through elasticity appears to be nonlinear, as illustrated in Figure 2. The data hint that the pass-through elasticity declines with concentration for lower levels of concentration. However, for firms in the tightest oligopoly markets, the pass-through elasticity is

[15] In analysis not reported in Tables 2 and 3, we included 4*CR* in the firm's 4-digit SIC code industry as a predictor instead of 4*CR* for the firm's PIMS markets (these two measures have a correlation of about 0.3). When concentration is measured this way, higher concentration also has a negative impact on the pass-through elasticity and is weakly significant. We did not include a variable corresponding to *TIGHTOLIGOP* when we used 4-digit SIC codes as our basis for industry definition, since nearly all 4-digit SIC industries have a 4*CR* of less than 90%.

Figure 2 Relationship Between Concentration and Pass-Through



significantly bigger than for firms in other markets. This latter result is consistent with the traditional industrial organization argument that firms in tight oligopolies would be more likely to rely on constant mark-up pricing rules to facilitate oligopolistic coordination. As discussed in §2, an adherence to such rules would tend to accentuate pass-through.

Turning our attention to the effect of competitive positioning on pass-through behavior, Models 2, 3, and 4 reveal the coefficients for $RELCOST \times \%\Delta RELCOST$ and $RELQUAL \times \%\Delta RELCOST$ are positive and significant. Thus, firms with quality advantages have significantly higher pass-through elasticities than firms with quality disadvantages, while firms with initial cost advantages have significantly lower pass-through elasticities than firms with cost disadvantages. Firms with existing competitive advantages thus react to cost changes in different ways according to the source (costs vs. quality) of their competitive advantage. Controlling for initial cost and quality advantage, initial market share does not have a significant effect on the pass-through elasticity. Model 4 examines whether the pass-through elasticity is systematically influenced by whether the firm also experienced an increase in relative quality (again, restricting attention to noncommodity industries). The coefficient on the interaction between $\%\Delta RELCOST$ and $\Delta\%\Delta RELQUAL$ is negative and statistically significant. This indicates that the greater the increase in relative quality experienced by a firm, the lesser is the extent to which a change in relative costs gets translated into a change in relative price. Although we cannot tell from the PIMS database why a firm's relative cost position changed, the fact that firms that simultaneously experienced relative quality and cost shifts exhibit different pass-through behavior from firms that experienced only a relative cost shift suggests that the competitive strategy decision about how to price out a cost change could well depend on the origin of the cost change—whether it arises from exogenous factors, such as factor price changes or exchange rate fluctuations or endogenously from changes in product attributes or marketing strategy.

Model 5 in Tables 2 and 3 provides further details on the relationship between competitive position and the pass-through elasticity by including parameters that reflect whether firms experienced an increase or decrease in their relative cost over the 4-year PIMS horizon. The results show that the effect of initial cost position on the pass-through elasticity is the same for both cost increases and cost decreases but the effect of initial quality position is not. When relative cost goes *up*, firms with initial quality advantages pass along the cost increase to a *lesser* extent than do other firms. For example, for relative cost increases, the pass-through elasticity for firms with a 10% initial quality advantage will be about 0.19, vs. 0.34 for firms with no initial advantage. By contrast, when relative costs go *down*, firms with initial quality advantages pass along the cost decrease to a *greater* extent than do firms with initial quality disadvantages. Although the complexity of these relationships defies a clean theoretical rationalization, they might in part reflect the strong relationship between quality and profitability that has been identified in other PIMS research. In the PIMS sample, firms with below-average quality typically enjoy profits that are well below those for firms with average or above-average quality (Buzzell and Gale 1987). Given this, eating a cost increase by shrinking price-cost margins might not be seen as a viable option by managers in low-quality firms, hence the more aggressive pass-through of cost increases. By contrast, these firms might see cost decreases as an opportunity to fatten what would otherwise be rather thin price-cost margins; if so, they would choose to

mainly bank their cost decreases, leading to a relatively small pass-through elasticity in these circumstances.

5. Summary and Conclusions

In this paper, we explore how market and firm characteristics affect the extent to which a firm's relative price changes when it experiences a change in its cost position relative to competitors. We do so by studying the firm's pass-through elasticity: The percentage change in a firm's relative price with respect to a 1% change in the firm's relative marginal cost. We find that the data confirm the two unambiguous predictions that emerge from a standard microeconomic analysis of pass-through: Firms in noncommodity industries have significantly greater pass-through elasticities than firms in noncommodity industries. And in noncommodity industries, a firm is more likely to "bank" an incremental cost advantage—i.e., not pass it along in the form of lower prices—when it operates close to full capacity, a result consistent with a priori theorizing. In addition, we find that market concentration has a nonlinear effect on the pass-through elasticity: pass-through weakly declines with concentration when concentration is relatively low. However, when firms interact in very tight oligopoly markets, they pass along a significantly greater fraction of cost changes than do other firms. This is consistent with the notion that firms in tight oligopolies rely on constant-margin pricing rules-of-thumb as a device to facilitate oligopolistic coordination. The pass-through elasticity also depends on the firm's initial competitive position. Firms with initial cost advantages generally adjust prices in response to cost changes to a lesser extent than firms with initial cost disadvantages. Firms with quality advantages generally adjust prices in response to cost changes to a greater extent than do firms with quality disadvantages. In the data, this is mainly driven by the fact that quality-disadvantaged firms have a pass-through elasticity for cost decreases that is virtually zero: These firms react to cost decreases by banking nearly all of the favorable cost shift in the form of a higher margin. Finally, firms that experience a change in quality at the same time that they experience a change in relative costs exhibit a different pass-through elasticity than firms that experience a change in relative cost but no change in relative quality. This suggests that the source of a firm's cost advantage might, in general, affect the way in which it exploits that advantage.

The fact that across a broad cross-section of firms, market and firm characteristics seem to affect the extent to which firms exploit cost advantages or cope with cost disadvantages suggests that a more detailed analysis of this question at the industry or strategic group level is likely to be fruitful. A particularly interesting question that we could not fully address with the aggregate data from PIMS is whether the particular drivers of a firm's cost advantage or disadvantage (e.g., scale, scope, experience) affect the way in which that advantage is exploited. A related question is whether the manner in which a firm's cost advantage or disadvantage evolves over time affects the way in which that cost advantage is exploited. Are, for example, cost advantages that arise from the internal development of organization capabilities over many years exploited differently from those that are acquired more quickly (e.g., through merger)? Analysis of these questions could help forge a closer link between the large literature on resource-based origins of competitive advantage and more traditional microeconomic theories of pricing and competitive behavior.

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