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ABSTRACT

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The study examines price behavior in tight oligopoly. The investigation proceeds from the premise that tacit collusion is the only rational response of firms comprising tight oligopoly. The study's thesis is that collusive conduct in tight oligopoly will reflect one of two general pricing patterns: (1) shared monopoly pricing, or (2) mark-up pricing. A unique empirical test of this dual price hypotheses is developed. The test focuses on the nature of price responses to cost and demand changes as reflected in a price equation that is estimated for each of forty-two four-digit SIC industries. The study's results indicate infrequent, but still notable, instances of shared monopoly pricing. More common is evidence of mark-up pricing, a general category within which demand proved to be significant in roughly half of the industries examined. Theoretical implications of these findings are discussed.

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This paper examines price behavior in tight oligopoly. The investigation proceeds from the commonly accepted premise that tacit collusion is the rational response of firms comprising oligopoly. Indeed, in this study the collusive assumption is adopted with special force. Theoretical and empirical research underscore the importance of high market concentration for effective collusion [26], [16], [12]. The empirical focus of this study is therefore limited to tight oligopoly.

The study's thesis is that collusive conduct under tight oligopoly will reflect either of two general pricing patterns: (1) monopoly pricing; or (2) mark-up pricing. The paper develops a test of this hypothesis and presents the empirical results.

Section I briefly reviews the theories of shared monopoly and mark-up pricing as collusive models of oligopoly. Section II develops a target-return model of mark-up pricing. Section III demonstrates how mark-up and monopoly pricing can be distinguished empirically, a distinction which serves as the basis for testable hypotheses. Section IV describes the estimation procedure of a price equation and the empirical results appear in Section V. Section VI presents the study's conclusions.

I. Two Views of Collusive Conduct

The seminal discussion of collusion under oligopoly is generally attributed to Chamberlin. Chamberlin emphasized the inevitability of recognized interdependence and "thus the conclusion of a monopoly price for any fairly small number of sellers." [4, p.49] Of course, subsequent works have emphasized that the actual practice of tacitly administering shared monopoly faces formidable technical problems [17], [30]. Briefly, these problems arise from such factors as interfirm cost differences, market share allocations, product differentiation, and policing agreements. However, research also suggests that these complications are less significant in tight oligopoly. Selten [32], in a games setting, demonstrates the extreme sensitivity of the shared monopoly solution to the number of firms. Further, Shepherd [34] notes that increased imitation of product characteristics and location is an increasingly rational strategy as the number of firms declines. It is also argued that the extreme fewness of tight oligopoly offers a better environment for maintaining tacit price agreements. Tight oligopolists will perceive a lower incentive to cheat, an increased probability of detection, and stronger industry social contracts [17], [23], [35]. Thus, it is reasonable to view the monopoly result as a viable solution in tight oligopoly, albeit, not the exclusive one.

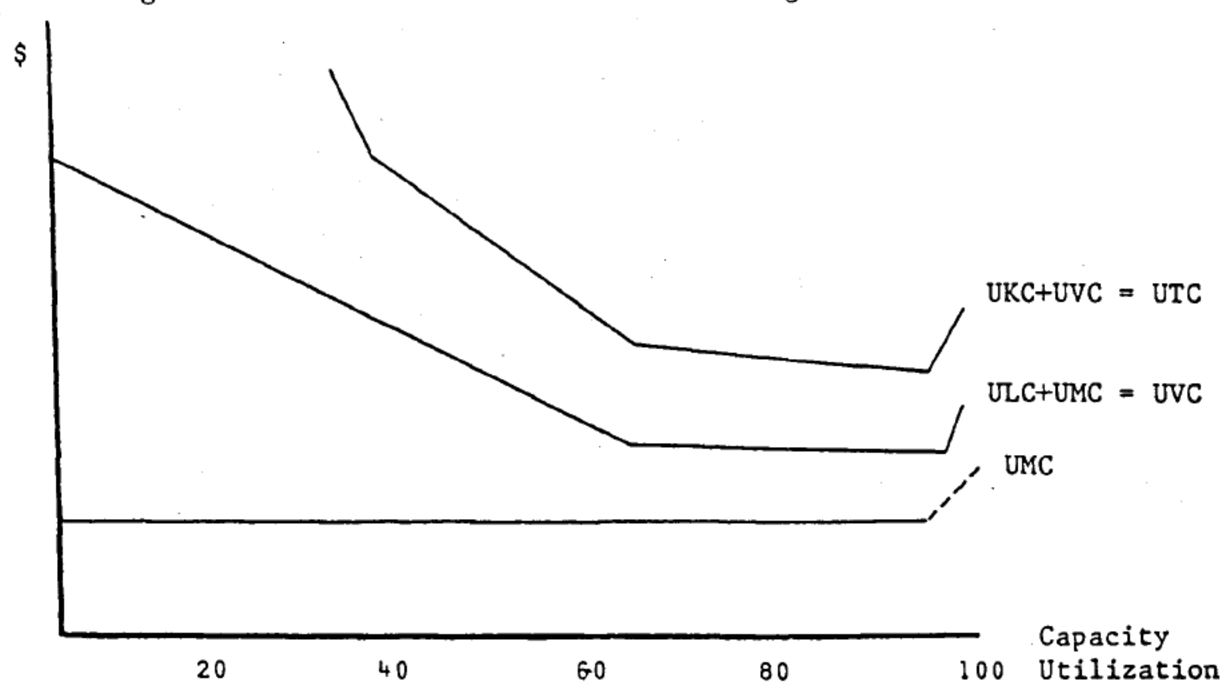
The appeal of collusion exists if there is a genuine prospect of economic profit, even though such profit falls short of the monopoly return. This possibility suggests the need for a second-best modeling of collusive oligopoly, and mark-up pricing has much to recommend it. For example, several case studies indicate that mark-up pricing is well suited to the common pricing objective of the individual firm [15], [21]. Furthermore, mark-up pricing is a tangible and workable guide to parallel price conduct [18], [11]. Indeed, perhaps the most important attribute of mark-up pricing as a collusive device is its simplicity of implementation and verification [10].

In sum, a dual interpretation of pricing under tight oligopoly may be appropriate. Monopoly price conduct should not be dismissed a priori, and mark-up pricing appears to be a practical, second-best collusive solution.

II. THE TARGET-RETURN MODEL

This study adopts a "target-return" model of mark-up pricing.[1] The foundation of the target-return model is a careful discussion of production cost. Figure 1 depicts unit cost (UTC) behavior summed by factor type. Unit material costs (UMC) are shown as constant over almost the entire range of plant capacity for two reasons. First, it is unreasonable to think of material usage as subject to the same laws of variable proportions as is often assumed for labor and capital. Second, under normal business conditions, materials purchases in manufacturing tend to be forward contracted at fixed prices.[2] An exception to constant UMC may arise, however, at very high levels of utilization. If high utilization rates for the firm correlate with robust economic activity in general, manufacturers may encounter material shortages. Unit material costs will rise if the firm resorts to higher-priced spot markets. This possibility is reflected in Figure 1a by the broken line rising at roughly 95 percent capacity.[3]

Figure 1: Cost Structure in Manufacturing Industries



Unit labor costs (ULC) are shown first to decline, then level off, and finally rise as a plant expands production. Within each range, the cost pattern may be attributed to short-run productivity and/or wage behavior. In the region of declining costs, both factors appear to be influential. While studies [40], [22] have found initially rising average labor productivity, declining ULC may also refect a wage bill phenomenon. Owing to union strength in manufacturing, one may assume that even during periods of slack demand, wages are downwardly rigid. Furthermore, search and training costs may dictate the retention of skilled workers during downturns.[4] The net result is quasi-fixed wage bill and thus a region of declining ULC. In the intermediate range of production, say anything upward from 60 percent, one may expect further productivity gains to be modest. Furthermore, there is no reason to believe that wages should change over this interval. These factors suggest a region of constant unit labor costs, although labor costs may rise near full capacity due to tightening labor markets and the payment of overtime rates.

The interpretation of the unit capital cost (UKC) is the traditional one, declining throughout as a fixed expenditure is spread over successively higher levels of output. The unit cost structure shown in Figure 1 is assumed typical of manufacturing industries. The only notable difference between these cost relations and the conventional textbook set is the region of constant marginal cost. There is, however, ample empirical support for this adjustment.[5]

Under a target-return strategy, the firm prices to achieve a desired rate of return on its capital investment, defined here as net expenditures on plant and equipment. A target-return model typically does not include labor or materials costs in the rate base[6]. The predictions of the target-return model follow from the assumption that the firm sets price relative to the unit costs incurred at a normal level of plant utilization. Unit costs at that point are commonly referred to as "standard volume" costs.[7] The formal target-return equation is written:

(1) $$P_t = UVC_s + (1+r)UKC_s$$

where P_t is the target price, r is the target rate of return, and s denotes the standard volume output. This equation, in conjunction with the cost structure developed earlier, constitutes a target-return model. The model is presented graphically in Figure 2. Note that price P_t is set as a mark-up over unit costs calculated for illustrative purposes at 80 percent of plant capacity. Specifically, the terms UVC_s and UKC_s in the equation correspond to the vertical distances ce and bc, respectively. The expression $(1+r)UKC_s$ is equal to ac, or alternatively, the distance ab is equal to $r(UKC_s)$. The latter magnitude may be interpreted as the actual dollar mark-up per unit.

The target-return model represents a unique supply and demand framework. As drawn here, the position of the demand curve DD implies that the firm will just sell its standard volume output at the target price and thus attain its desired return. More appropriately, however, DD should be understood as a notional demand curve -- the demand which the firm estimates for its product during the pricing decision. Of course, realized demand is likely to be above or below standard output. In the event that notional and realized demands differ only slightly, the firm is believed to maintain its normal operating rate by adjusting inventories accordingly. For wider deviations, the firm will make quantity adjustments within a production run. The central point is that

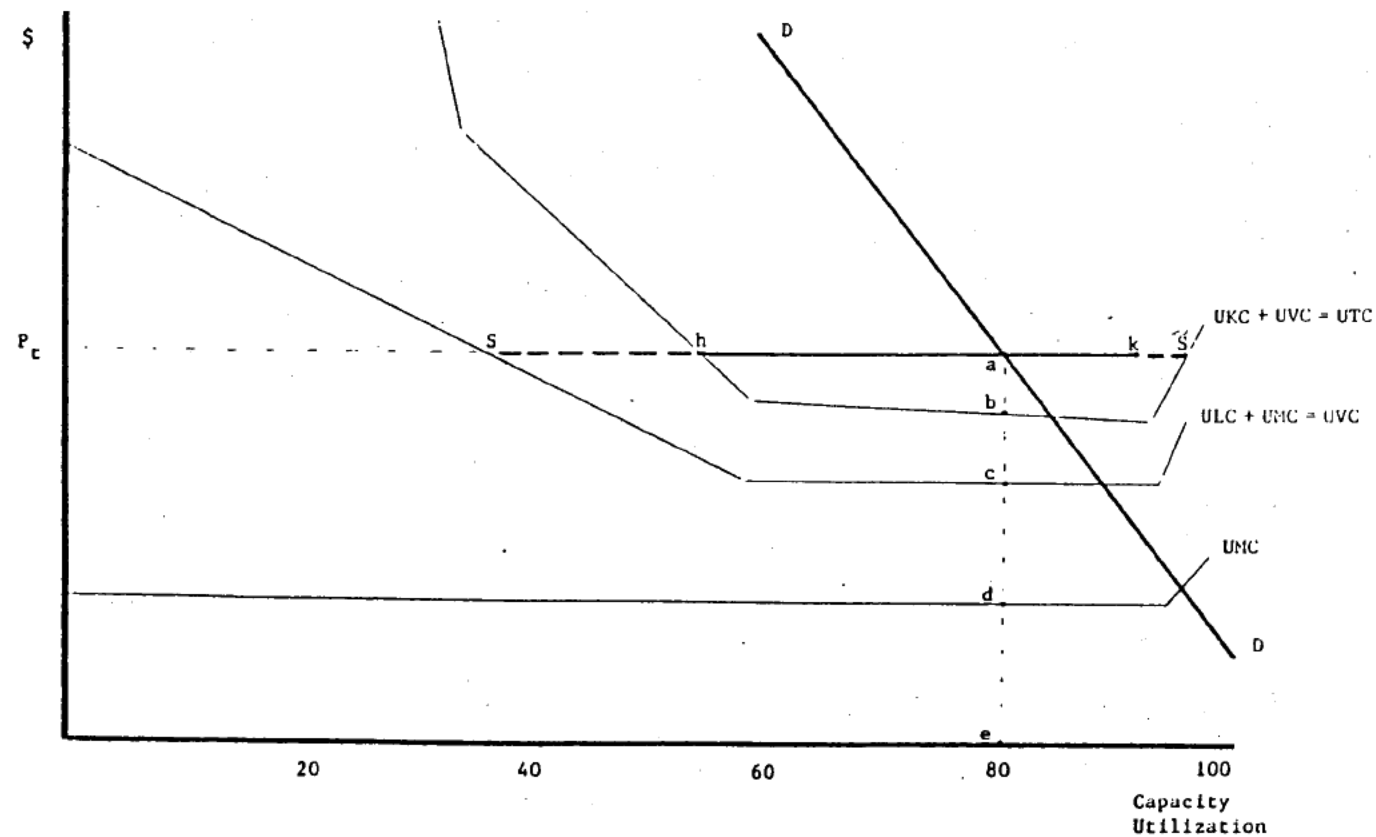


Figure 2: Target-Return Pricing Model

once the firm sets the target price, the supply curve is a horizontal interval at that price. In Figure 2, the length $\overline{SS}$ denotes the supply interval.

This concept of a supply interval has direct implications regarding whether the firm actually achieves its target profit. Recall that the target rate of return is applied to UKC_s. However, actual UKC, and thus the actual rate of return, will vary depending upon where the realized demand curve intersects the supply interval. To the extent that DD cuts to either side of point a, the firm will do slightly better or worse than targeted. In short, there is nothing inviolate about the target rate which firms apply in their price formula. Like any target, it can be aimed for and missed. Indeed, it seems quite reasonable that firms will have good and bad years, just as the model suggests.

One final comment regarding the interpretation of Figure 2 involves the distinction between the broken versus solid segments of the supply interval. Over the length $\overline{Sh}$, price (P_t) is less than unit total cost (UTC) and thus the firm is suffering losses. This segment is included within the supply interval, however, because price is still greater than unit variable costs (UVC). A further implication of this segment is that it may represent the range of operations over which price agreements are most apt to break down. The model is thus compatible with the common view that collusion is less likely in declining industries. The inclusion of the second broken segment, $\overline{kS}$, may be less appropraite. Over this small range, variable costs are rising so dramatically that they begin to cut substantially into the firms' previously profitable position. Therefore, it may be more accurate to truncate the supply interval at point k, reasoning that orders beyond this point are either not accepted or are assigned extended delivery dates. Alternatively, firms may operate in this less profitable range with the longer-term interest of insuring good customer relations, especially if the boom demand is perceived as temporary. Generally speaking, however, the slight difference between $\overline{SS}$ and $\overline{Sk}$ is trivial to the analysis. In presenting the hypotheses, $\overline{SS}$ is deemed the relevant supply interval.

III. THE HYPOTHESES

The hypotheses and empirical test focus on the responsiveness of price to changes in short-run cost and demand factors. The hypotheses are specified in terms of a general price equation:

$$P = \alpha + \beta_1 \text{ (UVC)} + \beta_2 \text{ (Dd)} \quad (2)$$

where P is unit price, UVC is unit variable cost, and Dd is a demand variable. This section demonstrates that shared-monopoly pricing and target-return pricing offer empirically distinguishable predictions for the coefficients β_1 and β_2.

Figure 3 illustrates the price responses of the two models to changes in marginal costs. To facilitate comparisons, the diagrams are contrived such that identical cost curves (MC = UVC) yield initially identical prices ($P_m = P_t$). Now consider an equal increase in cost in each model, e.g., a shift from MC to MC' and UVC to UVC'. Joint-profit maximization requires that the industry reduce output from Q to Q' and raise price from P_m to P_m'. Precisely how much price adjusts vis-a-vis output depends largely upon the elasticity of industry demand.[8] Eliminating the extremes of perfectly elastic and inelastic demand curves, it is clear that β_1 must lie between zero and one.

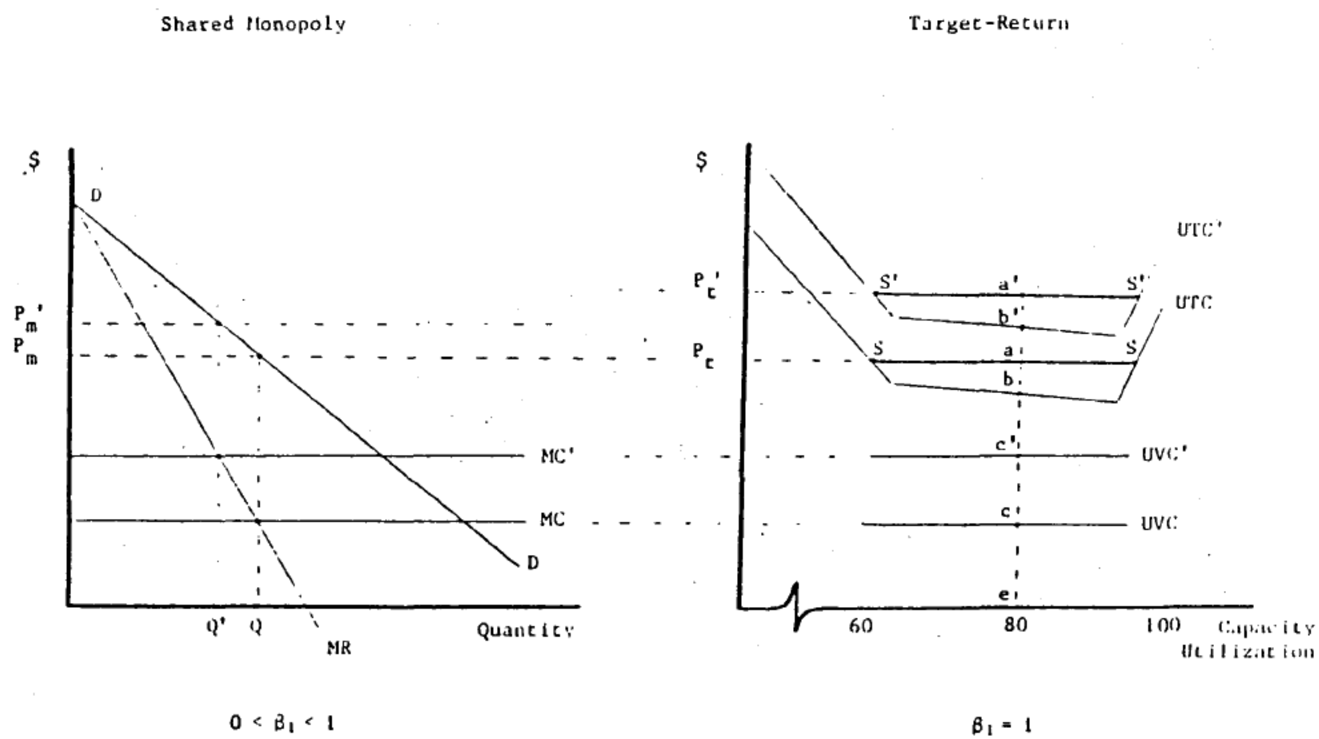


Figure 3: Price Responses to Cost Changes

Within a target-return model, the firm is understood to change prices when it recognizes a permanent change in its standard volume unit cost. For instance, the firm would know to adjust its standard cost figure in the wake of a labor settlement or an announcement from suppliers that materials prices were to be increased. Under a target-return strategy, permanent cost increases are passed along fully in prices.[9] This price response is shown in the right-hand diagram in Figure 3. In effect, the entire cost structure has shifted vertically by the amount of the unit variable cost change (cc' = bb' = aa'). The net result is that the target price is raised equally, from P_t to P_t'. A pure target-return model thus predicts that β_1 will be equal to one.

The analysis may now easily be expanded to include the implications of "full-cost" price behavior. Earlier it was noted that the major distinction between full-cost and target-return pricing is simply whether unit variable cost is considered part of the rate base. In equation form, the full-cost price (P_f) is expressed

(3) $$P_f = (1+r)\ (UVC_s + UKC_s)$$

as distinct from the previous target price equation

(1) $$P_t = UVC_s + (1+r)\ UKC_s$$

The implication of equation (3) for the hypotheses is that β_1 will be greater than one. Indeed, the difference between β_1 and unity should provide an estimate of the make-up factor r. In sum, the size of β_1 will indicate the pricing model followed by the industry -- a β_1 significantly less than unity corroborates the shared monopoly model, exactly unity a target-return model, and greater than unity a full-cost scheme.

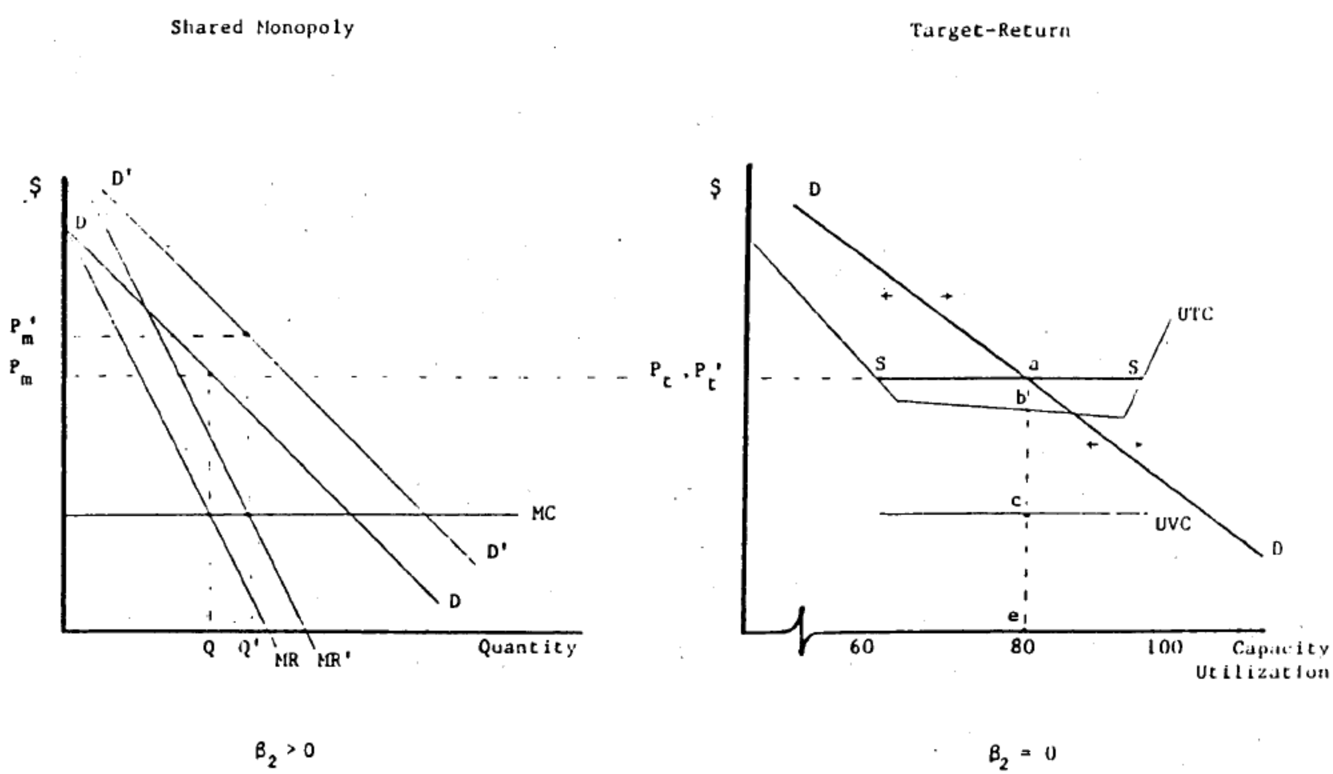


Figure 4: Price Responses to Demand Changes

Turn now to Figure 4 where the price predictions for demand changes are illustrated. In terms of equation (2), we are interested in the value of the coefficient β_2. As was the case in Figure 3, the graphs are drawn such that equilibrium price and output are identical in both models prior to a shift in demand. It is evident from the diagrams that, following a shift in demand, the joint-profit maximizing result is unique from the target-return prediction. In the latter case, the firm's short-run response is purely an output adjustment within the supply interval. Thus the coefficient β_2 is predicted to be zero ($P_t = P_t'$). In contrast, an industry that is maximizing joint-profits should display a β_2 greater than zero.

Combining the foregoing discussions of Figure 3 and 4, the formal hypotheses are as follows:

H_1: $0 < \beta_1 < 1$ and $\beta_2 > 0 \rightarrow$ shared monopoly

H_2: $\beta_1 = 1$ and $\beta_2 = 0 \rightarrow$ target-return pricing

H_3: $\beta_1 > 1$ and $\beta_2 = 0 \rightarrow$ full-cost pricing

where β_1 and β_2 are the coefficients of the unit variable cost and demand variables in a price equation.

IV. ESTIMATION PROCEDURE

The data for this study are from the Annual Survey of Manufacturers. The data are 1958-1976 annual observations for price and production variables for 42 four-digit industries as defined in the 1972 Standard Industrial Classification (SIC) Codes. The qualifying characteristic for the sample is fewness, either in an absolute or relative sense. The sample industries and details of the selection criteria appear in the Appendix.

Since the middle 1960's, considerable empirical work has been done with the price equation in manufacturing industries. Notable studies are those by Eckstein [6], Schultze and Tryon [31], Eckstein and Fromm [7], Eckstein and Wyss [8], Godley and Nordhaus [14], Ripley and Segal [29], Wilder [39], and Qualls [28]. However, the specific forms of the equation developed in most of these studies are only indirectly applicable here. The present study examines four-digit SIC industries with annual observations as compared with the quarterly data and broader two- or three-digit aggregation of prior studies. This distinction influences the estimation procedure in two notable respects.

First, annual data obviate the need for lags when modeling the speed of adjustment between variable cost changes and prices. This is a valuable simplification, since there is no strong agreement within the quarterly studies upon the appropriate lag structure.[10] Estimates range from no lag to a six month lag, with a three to four month gestation perhaps the most tenable.[11] Whatever the adjustment lag is, it is apparently well within the sphere of annual data, thus indicating no need for a lagged element in the equation. Furthermore, it is conceivable that as many as three variable cost changes may be captured within one year's price datum. These are important implications to emphasize. They bode well for the probable sensitivity of annual price data in capturing variable cost changes.

A second distinction between this study and most prior research concerns the operational definition of "standard" costs. Recall that under target-return pricing firms are perceived to base prices upon unit cost incurred at "normal" operating levels. Studies conducted either at the two-digit industry level or with quarterly data have notable advantages in defining standard volume. For one, indices of capacity utilization exist at the two-digit level. With such estimates, determining standard cost is a straightforward procedure.[12] Furthermore, quarterly data allow a secular definition of standard volume as a twelve-quarter moving average [30], [14]. Though both approaches to standardized cost have been supported empirically, neither method may be directly applied here. Utilization rates are not available at the four-digit level, and it is doubtful that the two-digit estimates could be extended in any meaningful way. The twelve-quarter moving average is also ruled out, because the data are annual.[13]

This definitional problem is not insurmountable however. For example, Sylos-Labini argues that with annual data standardizing unit costs may not be necessary. He maintains that "for empirical tests, annual data represents a reasonably good solution to the normalization problem" [36, p. 6]. Alternatively, Godley and Nordhaus [15] have treated annual standard volume as the level of output on the trend path. A similar approach is adopted here. Conceptually speaking, this approach is closely akin to the twelve-quarter moving average estimate, though technically the trend path value will not be as sensitive to structural shifts within the period as a moving average.

The transformations and variables required for the price equation are standard volume, standard unit variable cost, and inventory-shipments ratio deviation. Consider each in turn. Annual estimates of standard volume (Q^S) for each of forty-two industries are obtained via the following algorithm. First, an index of real output (Q) for the ith industry in the jth year is computed as

$$(4) \qquad Q_{ij} = \left[\frac{S + \Delta INV}{SPI}\right]_{ij}$$

where S = nominal value of annual shipments, ΔINV = nominal change in the value of year-end inventories, SPI = shipments price index, i = one to forty-two industries, and j = years from 1959-1976. Real standard volume (Q^s) for the ith industry in the jth year is then simply the corresponding fitted value for real output (Q) obtained by regressing output against time. Formally:

$$(5) \qquad Q^s_{ij} \equiv Q_{if} = a_1 + b_1 \text{ (year)}$$

where a_1 and b_1 are the OLS estimates obtained from the real output trend regression in each industry.

<u>Standard unit variable cost</u> <u>(UVC^s)</u> is a composite of three direct cost components and is written

$$(6) \qquad UVC^s_{ij} = \left[\frac{LC + MC + EC}{Q^s}\right]_{ij}$$

where LC = nominal labor costs, MC = nominal material cost, and EC = nominal energy cost.[14] Since Q^s is based upon the real output index derived in (5), any changes in variable expenditures are automatically adjusted for both productivity and real output changes. Therefore, the UVC^s variable accurately captures the influence of input-price changes on standard unit cost.

Two desirable features of this composite specification should be noted. First, by summing all variable cost components in the numerator, any changes in input prices are automatically weighted by factor shares. This is important because the effect of factor price changes on output prices depends on both the size of the former and the input's production weight. Output price changes are not costless to the firm and thus it is conceivable that the price of a relatively minor input could rise considerably without having a perceptible effect on the price of output.

A second notable advantage of the composite specification over the individual variable cost components is that the former more effectively considers factor substitution that may occur over time due to changing relative factor prices. For example, rising energy costs might prompt increased expenditure on energy-saving labor. If this substitution were permanent, linear estimates fitted to separate energy and labor cost components might both show larger standard errors than the merged index. In short, substitution between factors in the numerator is internalized in the composite specification.

The demand variable, Inventory-shipments ratio deviation (ISRD), is constructed on the premise that firms typically rely upon inventories for adjustments to short swings in demand. Therefore, excessive changes in inventories vis-a-vis a desired buffer level may serve as the principal precursor of a demand-induced price change. In fact, the inventory-shipments ratio can be a particularly sensitive variable because demand conditions affect both the numerator and the denominator in a manner magnifying the appropriate signal.[15] For example, increasing demand will simultaneously raise shipments and draw down inventories. Both changes reduce the value of the ratio. The sign of the partial relationship between price and the inventory-shipments ratio is negative ($\partial SPI/\partial ISR < 0$). This is noteworthy because it is the reverse of the partial relationship derived graphically in Section III. Therefore, the contingent demand relationship for monopoly pricing previously noted, $\beta_2 > 0$, is simply reversed to $\beta_2 < 0$. This reversal merely reflects the mechanics of an inventory-shipments ratio. Conceptually, the hypothesis is unchanged.

The actual demand variable which is used underwent two technical adjustments, though in spirit it retains the inventory-shipments concept. First, the data for inventories are year-end observations. Because firms often run down their inventories at this time for accounting purposes, mid-year estimates may be more representative of year-to-year demand fluctuations. A proxy for mid-year inventories is taken to be an average of two successive year-end inventories. A second adjustment in the inventory-shipments variable is warranted by the fact that roughly half of the industries displayed a statistically detectable downward, and in fewer cases upward, trend in the inventory-shipments ratio. It thus seems more appropriate to cast the demand variable as deviations from the inventory-shipments trend line. Therefore, the demand variable uses the residuals from the trend regression.

The final price equation that is estimated is:

$$SPI = \alpha_o + \beta_1 (UVC^S) + \beta_2 (ISRD) + \varepsilon \quad (7)$$

where SPI = the shipments price index, UVC^S = unit variable costs at standard volume, and ISRD = inventory-sales ratio deviations.

Before examining the results, a few caveats surrounding the estimation of equation (7) should be noted. First, the shipments price indices used here are based upon the Bureau of Labor Statistics' producer price indices (PPI). This presents a problem if one accepts the findings of Stigler and Kindahl [36]. They maintain that the PPI fails to reflect the possible difference between list prices and the more relevant transaction prices. If correct, the Stigler-Kindahl conclusion suggests that empirical studies will consistently underestimate the impact of falling demand on prices. It is also noteworthy, however, that two more recent studies, both interpreting the Stigler-Kindahl data, fail to corroborate their findings. Indeed, Coutts et al conclude that, "inspection of the aggregate results leads one to believe that the Stigler/Kindahl transaction price index shows more signs of stickiness than the official index" [5, p. 7]. Weiss, somewhat less contradictory, simply concludes, "there is no significant bias in the two sets of series with respect to concentration so the studies using BLS series are meaningful" [37, p. 19].

From an econometric perspective, the time-series nature of the data raises the issue of serial correlation.[16] Serial correlation proved to be a problem in roughly three-quarters of the industry regressions. To correct for this problem, a Cochrane-Orcutt iteration was performed. This procedure proved to be an adequate correction for all but a few industries in which the Durbin-Watson statistic remained in the indeterminate region.[17]

V. EMPIRICAL FINDINGS

Section III demonstrated that monopoly pricing and mark-up pricing can be clearly distinguished in terms of the models' predicted price sensitivity to changes in variable costs and demand. The testable hypotheses were formally stated:

H_1: $0 < \beta_1 < 1$ and $\beta_2 < 0 \rightarrow$ Shared Monopoly

H_2: $\beta_1 = 1$ and $\beta_2 = 0 \rightarrow$ Target-Return Pricing

H_3: $\beta_1 > 1$ and $\beta_2 = 0 \rightarrow$ Full-Cost Pricing

where β_1 and β_2 refer to the estimated coefficients for the unit variable cost and demand variables in a price equation.

Table 1 lists eight industries meeting the conditions of shared monopoly as defined in H_1. For each industry included in Table 1, β_1 falls significantly between zero and one, and the sign of β_2 is appro-

Table 1

REGRESSION RESULTS: HYPOTHESIS OF SHARED MONOPOLY

Industry description	SIC	Dependent variable	Intercept	UVC	ISRD	R^2	F	DW
Cellulosic Manmade Fibers	2823	SPI	0.474 (24.415)†	0.671 (27.465)‡ (13.499)	-1.150 (-5.234)	.974	264.06	1.78[c]
Organic Fibers, Noncellulosic	2824	SPI	0.857 (11.657)	0.405 (4.436) (6.524)	-0.727 (-1.816)*	.932	96.60	2.08[c]
Carbon Black	2895	SPI	0.510 (26.736)	0.888 (39.677) (4.980)	-0.448 (-1.898)*	.994	1202.41	2.12
Gypsum Products	3275	SPI	0.461 (10.551)	0.745 (13.539) (4.629)	-2.081 (-2.680)	.980	346.50	1.69[c]
Household Laundry Equipment	3633	SPI	0.761 (3.177)	0.748 (5.334) (1.803)*	-1.944 (-2.216)**	.947	124.80	1.56[c]
Household Vacuum Cleaners	3635	SPI	0.676 (6.561)	0.596 (3.711) (2.518)**	-1.677 (-3.545)	.931	94.10	1.45[c]
Sewing Machines	3636	SPI	1.273 (4.684)	0.497 (4.364) (4.407)	-0.415 (-2.031)*	.953	140.42	1.90[c]
Photographic Equipment	3861	SPI	0.997 (6.627)	0.584 (3.415) (2.437)**	-1.605 (-1.862)*	.954	145.74	2.01[c]

† t-ratios are in parentheses.
‡ For UVC, two t-ratios are reported. The upper t-ratio tests whether the coefficient is significantly greater than zero. The lower t-ratio tests whether the coefficient is significantly less than one.
* Denotes significance at the 5% level (one-tailed test).
** Denotes significance at the 2.5% level (one-tailed test).
All other coefficients are significant at the 1% level (one-tailed test).
c Equation was run with Cochrane-Orcutt iterative technique for these industries.

priately negative and significant. Generally, the results are of good statistical quality. The results in Table 1 indicate that roughly one-fifth of the tight oligopolies examined in this study approximate monopoly price conduct as defined in H_1. The results suggest that monopoly pricing exists, but it is not so prevalent that it disturbs any a priori expectation one might have held.

Table 2 contains the results conforming to the general hypothesis of mark-up pricing. Included are both target-return and full-cost pricing, encompassing both H_2 and H_3. These two results are distinguished within the table by reference to the second t-statistic reported under unit variable cost (UVC^s).[18] The table reveals that nineteen industries, almost half of the sample, are contained within the general mark-up category. In all cases, the demand coefficient β_2 is insignificant. Unit variable costs reflect price responsiveness closely paralleling either target-return pricing ($\beta_1 = 1$) or full-cost pricing ($\beta_1 > 1$). For example, the estimates of β_1 for industrial gases, small arms ammunition, and motor vehicles show a remarkably clean target-return result ($\beta_1 = 1$). Regarding full-cost pricing ($\beta_1 > 1$), the estimates of β_1 for cane sugar, beet sugar, earthenware utensils, primary copper, primary lead, metal cans, vehicular lighting, and electron tubes reflect a "reasonable" percentage mark-up.[19] Within the mark-up category neither target-return (nine industries) nor full-cost pricing (ten industries) dominates.

The results for the remaining fifteen tight oligopolies in the sample are reported in Table 3. These industries all evidence mark-up pricing in terms of variable cost changes ($\beta_1 \geq 1$), but they also display

Table 2

REGRESSION RESULTS: HYPOTHESIS OF MARK-UP PRICING

Industry description	SIC	Dependent variable	Intercept	UVC	ISRD	R^2	F	DW
Cane Sugar & Refining	2062	SPI	0.029 (1.1853)+	1.108 (48.989)‡ (4.792)**	1.723 (1.526)	.989	626.40	2.10^c
Beet Sugar	2063	SPI	-0.138 (-3.004)	1.441 (28.376) (8.665)**	-0.126 (-0.246)	.979	340.92	2.22^c
Cigarettes	2111	SPI	0.814 (2.558)	1.258 (4.678) (0.948)*	-0.005 (-0.011)	.975	267.19	2.14^c
Industrial Gases	2813	SPI	0.364 (5.857)	1.030 (12.189) (0.355)*	3.694 (0.986)	.970	228.44	1.84^c
Vitreous China Food Utensils	3262	SPI	-0.205 (-4.921)	1.725 (26.496) (11.135)**	0.031 (0.049)	.980	368.51	2.08
Fine Earthenware Food Utensils	3263	SPI	-0.138 (-3.706)	1.384 (26.729) (7.418)**	0.438 (0.865)	.936	183.87	1.69^c
Primary Copper	3331	SPI	0.012 (0.323)	1.117 (25.841) (2.711)**	-0.441 (-1.109)	.979	342.02	1.68
Primary Lead	3332	SPI	-0.093 (-1.322)	1.195 (16.059) (2.622)**	0.449 (0.903)	.968	212.30	1.95^c

Explanatory notes appear at end of table.

(continued)

Table 2--Continued

Industry description	SPI	Dependent variable	Intercept	UVC	ISRD	R^2	F	DW
Metal Cans	3411	SPI	-0.055 (-1.448)	1.370 (26.127) (7.067)**	0.712 (0.903)	.979	350.44	1.67
Small Arms Ammunition	3482	SPI	0.141 (1.158)	1.047 (6.313) (0.281)*	-0.196 (-0.673)	.763	24.12	1.26
Household Refrigerators & Freezers	3632	SPI	0.119 (0.979)	1.161 (7.513) (1.043)*	-0.944 (-0.756)	.913	73.27	1.38^c
Vehicular Lighting Equipment	3647	SPI	-0.146 (-2.431)	1.556 (18.143) (6.483)**	0.728 (1.611)	.959	178.20	1.82
Telephone, Telegraph Equipment	3661	SPI	0.358 (2.438)	0.822 (4.244) (0.918)*	1.427 (0.785)	.603	11.41	1.38^c
Electron Tubes, Receiving Type	3671	SPI	-0.052 (-1.313)	1.604 (22.766) (8.573)**	-0.661 (-1.211)	.981	358.03	1.91^c
Motor Vehicles & Car Bodies	3711	SPI	0.126 (4.615)	1.051 (29.709) (1.447)*	0.605 (1.093)	.987	522.10	1.82^c
Aircraft Engines & Engine Parts	3724	SPI	0.371 (2.033)	1.102 (10.763) (0.997)*	0.594 (1.276)	.990	707.40	2.00^c

Explanatory notes appear at end of table.

(continued)

Table 2--Continued

Industry description	SPI	Dependent variable	Intercept	UVC	ISRD	R^2	F	DW
Space Propulsion Units & Parts	3764	SPI	-0.188 (-2.929)	1.544 (17.627) (6.210)**	-0.061 (-0.090)	.957	173.66	1.07[c]
Tanks & Tank Components	3795	SPI	-0.117 (-0.897)	1.348 (8.074) (2.086)*	-0.355 (-0.682)	.824	34.98	1.78
Hard Surface Floor Coverings	3996	SPI	0.825 (2.967)	0.763 (4.490) (1.391)*	-0.708 (-0.812)	.919	78.92	1.99[c]

† t-ratios are in parentheses.
‡ For UVC, two t-ratios are reported. The upper t-ratio tests whether the coefficient is significantly greater than zero. The lower t-ratio tests whether the coefficient is equal to or significantly greater than one.

* Denotes UVC coefficient equal to one (one-tailed test).
** Denotes UVC coefficient significantly greater than one (one-tailed test).
All significance tests are at the 1% level (one-tailed test).
c Equation was run with Cochrane-Orcutt iterative technique for these industries.

Table 3

REGRESSION RESULTS: MARK-UP PRICING WITH DEMAND SENSITIVITY

Industry description	SIC	Dependent variable	Intercept	UVC	ISRD	R^2	F	DW
Cereal Breakfast Foods	2043	SPI	0.492 (4.026)†	1.310 (16.105)‡ (3.816)**	-8.241 (-5.181)	.994	1194.59	1.78[c]
Wet Corn Milling	2046	SPI	0.177 (3.090)	1.164 (21.204) (2.994)**	-6.672 (-2.656)	.980	364.97	2.03
Chewing Gum	2067	SPI	0.057 (1.754)	1.768 (28.467) (12.368)**	-0.940 (-1.833)***	.983	408.48	2.14[c]
Tire Cord & Fabric	2296	SPI	-0.190 (-2.715)	1.317 (17.205) (4.144)**	-1.398 (-1.858)***	.966	215.31	1.97
Pressed & Molded Pulp Goods	2646	SPI	0.081 (3.714)	1.275 (41.259) (8.905)**	-1.599 (-2.828)	.985	469.65	1.86[c]
Flat Glass	3211	SPI	0.012 (0.126)	1.447 (9.196) (2.842)**	-3.924 (-3.928)	.852	43.32	1.19[c]
Glass Containers	3221	SPI	-0.018 (-0.527)	1.382 (27.494) (7.600)**	-1.600 (-1.919)***	.981	389.72	2.16
Mineral Wool	3296	SPI	-0.021 (-0.605)	1.429 (29.239) (8.785)	-3.206 (-1.846)***	.995	1283.62	2.30[c]

Explanatory notes appear at end of table.

(continued)

Table 3 --Continued

Industry description	SPI	Dependent variable	Intercept	UVC	ISRD	R^2	F	DW
Electrometal-lurgical Products	3313	SPI	-0.143 (-3.013)	1.254 (27.570) (5.593)**	-1.214 (-3.640)	.980	344.02	2.20[c]
Primary Zinc	3333	SPI	-0.214 (-2.705)	1.333 (20.740) (5.188)**	-1.669 (-5.190)	.992	885.97	2.44[c]
Primary Aluminum	3334	SPI	0.084 (1.165)	1.141 (17.687) (2.192)**	-0.851 (-2.016)***	.985	459.64	2.20[c]
Aluminun Sheet, Plate, & Foil	3353	SPI	-0.091 (-1.400)	1.235 (17.817) (3.385)**	-1.828 (-2.802)	.977	293.87	1.94[c]
Carbon & Graphite Products	3624	SPI	-0.020 (-0.654)	1.458 (33.818) (10.638)**	-1.079 (-2.093)***	.987	526.56	2.09[c]
Cathode Ray TV Picture Tubes	3672	SPI	0.293 (3.057)	1.013 (11.645) (0.153)*	-5.638 (-2.066)***	.955	148.64	2.29[c]
Primary Batteries, Dry & Wet	3692	SPI	0.051 (0.569)	1.552 (10.942) (3.892)**	-1.958 (-2.061)***	.983	406.27	1.32[c]

† t-ratios are in parentheses.
‡ For UVC, two t-ratios are reported. The upper t-ratio tests whether the coefficient is significantly greater than zero. The lower t-ratio tests whether the coefficient is equal to or greater than one.
* Denotes UVC coefficient equal to one (one-tailed test).
** Denote UVC coefficient significantly greater than one (one-tailed test).
*** Denotes significance at the 5% level (one-tailed test).
All other coefficients are significant at the 1% level (one-tailed test).
c Equation was run with Cochrane-Orcutt iterative technique for these industries.

significant demand sensitivity ($\beta_2 < 0$). An outcome of mark-up pricing with demand sensitivity is not a result that may be associated with either pure monopoly pricing or pure mark-up pricing. Though the simple dual proposition did encompass a majority of the industry results (twenty-seven of forty-two), roughly one-third of the industry results suggest a third category of mark-up pricing with demand sensitivity.

Before interpreting these findings, one general empirical result is noteworthy. In the past, specification of the demand variable, particularly with annual data, has met with less than uniform success.[20] The fact that the ISRD specification reflected demand influences significantly in twenty-three industries speaks well for the specification adopted in this study.

VI. CONCLUDING REMARKS

The focus of this paper has been on developing an empirical test that distinguishes two theoretical models of pricing in tight oligopoly. Arguably, these two models represent extremes--monopoly pricing reflecting pure joint maximization and mark-up pricing reflecting imperfect cooperative conduct. As the results in Tables 1 and 2 reveal, the empirical scheme performs well. Roughly one-fifth of the sample industries reflect pure monopoly pricing, and another half appear to be mark-up pricers. It is also noteworthy, however, that the test displays flexibility, identifying a third distinct category of mark-up pricing with demand sensitivity.

Furthermore, the three observed pricing patterns lend themselves to plausible interpretation. Bain [1, p. 328] sets the keynote for one such interpretation quite clearly:

> . . . if the firms of an industry pursue a *rigid* margin-adding policy--always adding the same uniform margin to normal average cost in order to determine price, regardless of the current rate of output demanded or of other immediate market considerations--they can generally at best attain only a *rough* or *crude long-run* approximation to the prices which would maximize joint or separate profits. Except under very special limiting conditions of demand and cost variation, precise month-to-month or year-to-year profit maximization (of whatever sort) would require some variation of the margin with variations in demand and in the rate of output. However, appropriate choice of a certain rigid margin is potentially quite consistent with a long-run average approximation to a profit-maximizing price. And if the margins applied are indeed varied with varying market conditions, the pricing procedure in question is potentially consistent with fairly precise maximizing policies. (Emphasis added.)

Bain's distinction between "rigid" mark-ups and those that float with demand, and the parallel contrast between "crude long-run" maximizing policies versus "fairly precise" ones, is clearly corroborated by Tables 2 and 3. At the same time, the monopoly price implications revealed in Table 1 should not be ignored. Consider the following.

The pure mark-up policy may represent those industries where complications in implementation or enforcement are particularly severe. In such an environment, the pure mark-up policy reflects the pragmatic acceptance among industry members that the probable benefits of a more finely honed mark-up policy--i.e., one attuned to demand--are offset by a greater likelihood that more intricate methods of coordination may in fact undermine industry discipline.[21] In this sense, strict adherence to simple mark-up rules would seem to represent Fellner's concept of "quasi-agreement" with special force. Mark-up pricing with demand sensitivity might then be interpreted as a better administered collusive effort, indeed, a "fairly precise" approximation of monopoly conduct. Clearly, these interpretations are consistent with the respective results in Tables 2 and 3. However, neither interpretation directly acknowledges the ideal, and it is in this regard that the results in Table 1 are relevant. In other words, pure mark-up pricers may do well from the standpoint of joint-profit maximization; indeed, perhaps as well as possible given their industry environment. But mark-up pricers sensitive to demand probably do better, leaving a few industries that appear to approximate monopoly performance. Though this interpretation deserves further investigation, it is quite compatible with both profit maximizing behavior under varying administrative constraints, and the results.

A second noteworthy implication of the results is that mark-up pricing appears to be the predominant price-cost relationship (34 of 42 industries), but then becomes a dual price pattern depending on the significance of demand. The varying influence of demand within the general mark-up price pattern may represent the distinction between short-run and long-run maximizing conduct in tight oligopoly. As Bain notes, mark-ups which "indeed vary with market conditions" may be read as "fairly precise maximizing policies." Alternatively, some tight oligopolies may focus on long-run profits and thus price to deter entry. Where this is the case, it is perfectly consistent that "limit" prices should not respond to rising demand since to do so might invite entry. Cost changes, on the other hand, should precipitate price changes since the limit-price level will vary directly and uniformly with cost conditions. In this sense, the results in Table 2 versus Table 3 might be viewed as further support for the relevance of the distinction between long-run and short-run maximizing behavior in oligopoly. Thus, the mark-up price results in general reflect pricing behavior consistent with profit maximization under an entry constraint.

FOOTNOTES

1 Mark-up pricing is a generic term. There are actually several ways of formally specifying a model which captures the spirit of mark-up pricing. For example, the terms "cost-plus," "full-cost," and "target-return" pricing each imply minor variations within the general mark-up theme. For a discussion of these differences, see Eckstein and Fromm [7, pp. 1165-66] and Ripley and Segal [29, p. 264]. Largely, the model presented here builds upon presentations by Blair [2], [3] and Eckstein and Fromm.

2 Eckstein and Fromm [8, p. 1165].

3 It is important to differentiate between the factors underlying this rising segment of UMC and those shifting the entire curve. Consider the following example. A copper wire manufacturer with a given sales expectation normally purchases copper rod in forward markets three months prior to delivery for production. Say the firm buys May copper for delivery in August. Assume now that August wire demand runs higher than anticipated. Any extra production must occur with materials bought in the August spot market, at which time the price of copper rod is likely to have risen. As a result, unit costs rise, but only at near full-capacity. For all previous units, the lower forward materials price determines cost. However, if the higher spot price is an accurate signal of future trends, then forward prices will also rise. It is only in the case of higher forward contract prices, i.e., permanent price increases, that the UMC curve shifts.

4 See Okun [25, pp. 107-114].

5 Constant marginal cost over a range has been a common finding in many empirical industry studies. As Heflebower states in his review of full cost pricing, "There is now significant evidence to the effect that, in manufacturing operations at least, marginal costs do not vary for a fairly wide range of output rates. . . . Downward from the neighborhood of the output for which the plant was designed as much as 30 percent. . . . That marginal costs are horizontal in this range has been demonstrated almost without exception in statistical investigations." [18, p.320]. Also see Johnston [19].

6 This is the major distinction between target-return and full-cost pricing that was noted earlier. As will be shown in Section III, this difference can be tested empirically.

7 Given that price is a mark-up on unit costs, and that unit capital costs vary with output, it is obvious that the designation of standard volume is not an incidental aspect of price determination. Unfortunately, the theory offers no clear rule on this point. While case studies of heavy manufacturing have indicated that standard volume may fall in the range of 75 to 80 percent capacity, broader considerations would lead one to suspect that "normal" utilization levels will vary substantially according to the type of industry. However, as a theoretical construct, one may assume that it represents 80 percent of plant capacity. In defense of this assumption, recognize that misspecification of standard volume only affects the initial price level. On balance, however, it does not alter the model's predictions regarding how that price level subsequently responds to either rising cost levels or shifts in demand.

8 It could also depend on the slope of the marginal cost curve. Of course, as shown here, we are assuming a range of constant marginal costs.

9 The purest of demand theory is inclined to balk at the notion of firms being able to pass cost increases along fully via price increases. Okun discusses the likelihood of such pass-throughs at length emphasizing the importance of search cost, transaction cost, and continuity in the buyer-seller relationship [25, pp. 138-156].

10 Nordhaus [24, p. 38].

11 Eckstein and Fromm state, "...the adjustment process appears to be short, with much of the adjustment coming within three months, most of it within six" [7, p. 1171]. This conclusion is corroborated by slightly different evidence from a recent study of British manufacturing. Coutts, Godley, and Nordhaus found that the extremes in the length of production periods over which price policy is likely to be incremented run from nine to twenty-three weeks [5, pp. 34-41].

12 Eckstein and Fromm [7, pp. 1167-69].

13 Furthermore, an annual moving average is too costly. With only nineteen observations, something as small as a three-year moving average would cost two degrees of freedom. Add to this the required adjustment for explanatory variables and the analysis is down to fourteen degrees of freedom.

14 Of the fifteen production variables included in the data base, energy cost was the only one for which a complete nineteen year time series was not available. Observations were for the years 1958, 1961, 1963, 1967, 1971-1976. Therefore, the missing values in this variable were interpolated from the trend line fitted to the available energy observations.

15 There may be some concern whether the magnifying characteristic of the inventory-shipments ratio is desirable. One might contend that this imposes a specification bias in the equation. However, the author believes that the added sensitivity of the ratio is desirable since the data are annual rather than quarterly. Clearly, detecting demand influences will be more difficult with annual data for two reasons: (1) one has fewer observations, and (2) the longer period between observations suggests that an interim lull in demand could go undetected by the data.

16 Consideration was also given to the possibility of multicollinearity. Since the equation involves only two independent variables, their simple correlation coefficient provides a sufficient test [20, p. 163]. The absolute mean value of the correlation coefficient between UVC_s and ISRD was 0.29, indicating the lack of a problem.

17 The alternative correction procedure of first-differencing was not used here for two reasons. First, first-differencing would have cost an additional degree of freedom further reducing the statistical test to the fourteen-degree level. Second, first-differences assumes the error term correlation (ρ) is equal to ±1 [27, pp. 110-11]. This condition is not satisfied in the majority of industries. The absolute mean value of ρ on the final iteration was 0.58.

18 In Table 3, two t-statistics are reported. The upper t-statistic tests whether the coefficient is significantly greater than zero. The lower t-statistic tests whether the coefficient is equal to one, or greater than one. A single asterisk denotes $\beta_1 = 1$, and a double asterisk denotes $\beta_1 > 1$.

19 A very rough approximation of the mark-up might be determined as follows. During the period 1963-1977, the average after-tax return on stockholders' equity for manufacturers with assets over $1 billion was 12.5 percent [30, p. 92]. A corporate profit tax rate of 49 percent implies that the pre-tax return would be roughly twice the stockholder return thus in the vicinity of a 25 percent mark-up. Again, this a very crude estimate, but given the aggregated nature of the data, perhaps a rough approximation is appropriate.

20 See Nordhaus [24, pp. 41-42].

21 As Scherer notes, "Poorly coordinated efforts to increase short-run profits under changing and uncertain demand and cost conditions can, through shortsightedness and misinterpretation, deteriorate into moves and countermoves that reduce rather than increase group profits." [30, p. 188].

APPENDIX

SAMPLE OF TIGHT OLIGOPOLIES[1]

Industries	SIC Code	Number of Firms	Four-Firm Concentration Ratio	Coverage Ratio
Cereal Breakfast Foods	2043	34	90	84
Wet Corn Milling	2046	26	63	97
Cane Sugar Refining[2]	2062	22	60	98
Beet Sugar[2]	2063	16	60	100
Chewing Gum	2067	15	87	88
Malt	2083	30	48	99
Cigarettes	2111	13	84	100
Tire Cord and Fabric	2296	9	84	97
Pressed and Molded Pulp Goods[3]	2646	32	85	97
Industrial Gases[3]	2813	105	72	92
Cellulosic Man-made Fibers	2823	12	96	95
Organic Fibers, Noncellulosic	2824	36	74	97
Carbon Black	2895	11	74	95
Flat Glass	3211	11	92	95
Glass Containers[3,4]	3221	27	80	99
Vitreous China Food Utensils[2]	3262	32	60	88
Fine Earthware Food Utensils[2]	3263	17	60	97
Gypsum	3275	44	80	97
Mineral Wool	3296	66	75	93
Electrometallurgical Products	3313	27	74	87
Primary Copper[4]	3331	11	80	98
Primary Lead	3332	12	93	98
Primary Zinc	3333	11	66	70
Primary Aluminum	3334	12	91	76
Aluminum Sheet, Plate, and Foil	3353	24	65	99
Metal Cans[4]	3411	134	90	98
Small Arms Ammunition	3482	57	89	98
Carbon and Graphite Products	3624	58	86	98
Household Refrigerators, Freezers	3632	30	85	85
Household Laundry Equipment	3633	20	83	91
Household Vacuum Cleaners	3635	34	75	85
Sewing Machines	3636	72	84	93

(continued)

Industries	SIC Code	Number of Firms	Four-Firm Concentration Ratio	Coverage Ratio
Vehicular Lighting Equipment	3647	46	78	94
Telephone, Telegraph Apparatus	3661	157	94	99
Electron Tubes, Receiving Type	3671	21	89	94
Cathode Ray TV Picture Tubes	3672	69	83	98
Primary Batteries, Dry and Wet	3692	30	85	98
Motor Vehicles and Car Bodies	3711	165	96	100
Aircraft Engines, Engine Parts	3724	189	77	94
Guided Missiles, Space Vehicles	3761	23	62	95
Space Propulsion Units, Parts	3764	22	59	87
Tanks and Tank Components	3795	18	99	77
Photographic Equip., Supplies[3]	3861	555	80	96
Hard Surface Floor Coverings	3996	18	91	99

[1] An industry is considered a tight oligopoly depending on either of two structural conditions. One, the four-firm concentration ratio must exceed 75 perscent. This cirterion is consistent with Palmer's [26] finding that a proclivity for collusion appeared to set in for CR_4>70 percent. Also, until the revision in June of 1982, a CR_4 greater than 75 percent was grounds for denying a horizonal merger under the Justice Department Merger Guidelines of 1968. An alternative condition for inclusion in the sample is that the number of firms in the industry be less than thirty-five. The selection of this figure was largely a function of the data. Analysis of the number of firms across industries revealed a clear lapse between thirty-five and fifty firms. Therefore, thirty-five was selected as the ceiling. The data on CR_4 and the number of firms are those for 1972. These 1972 statistics will thus be defining the sample for the entire 1958-1976 period. Obviously, then, a substantial degree of structural stability is being assumed for this period. However, empirical studies of concentration trends in manufacturing support this assumption. See Scherer [30, pp. 67-74].

[2] Products are considered substitutes and thus the market definitions are too narrow. Following Qualls [28],the CR_4 is weighted average across substitute markets.

[3] Product class is too broadly defined. Adopted Shepherd's [33] adjusted CR_4.

[4] Markets are regional. Adopted Shepherd's [33] adjusted CR_4.

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