F. Owen Irvine, Jr.
Wesleyan University

Econometric Tests of the Hypothesis that Market-Maker Firms Follow a "Short-Run Inventory-based Pricing Policy"*

This paper presents the results of an econometric study of the pricing behavior of a retail department store over time. Over the long run, variations in the level of operating costs are shown to be the major determinant of the store's margin over the wholesale cost of the goods sold. On the other hand, the substantial short-run variations in this margin are largely explained by the store's use of a "short-run inventory-based pricing policy." This policy requires an inventory-carrying store in the upcoming period to post a price below the long-run competitive price upon observing its actual inventory level above its optimum inventory level, and to post a price above the long-run competitive price upon observing its actual inventory level below its optimum level. These results suggest that the rate of consumer commodity inflation will be influenced by the condition of distribution-sector inventories.

Our inability to forecast accurately the rate of inflation has been well documented. Gordon (1975), for example, points out that the root mean-square error of the Livingston panel forecasts of the consumer price index 6 months ahead was 3.5 percentage points at an annual rate for a period running from late 1971 through 1975. The forecasting performance of large-scale econometric models has not been much better (see McNees 1976). To improve our understanding of the inflationary process, and, in turn, our forecasting ability, it has been suggested that pricing behavior should be studied on a more disaggregated level.[1] In this spirit, this paper presents the results of an econometric study of the pricing behavior of a retail department store over time.

An equation is specified and estimated which explains the month-to-month variations in the margin over the wholesale cost earned by the total

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1. See William Nordhaus's (1975) comments on Gordon's (1975) article and Nordhaus's (1976) paper. Okun (1975) and Popkin (1974) also advocate such a disaggregated approach.

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department store.[2] The data base utilized consists of monthly time series extending for 15 years (1950–64) on the various operating statistics of a typical medium-sized independent Midwestern department store. In particular, we were interested in testing whether the store followed a "short-run inventory-based pricing policy" which requires an inventory-carrying store in the upcoming period to post a price below the long-run competitive price upon observing its actual beginning inventory level above its optimum inventory level, and to post a price above the long-run competitive price upon observing its actual inventory level below its optimum inventory level. In a previous paper (Irvine 1979) I demonstrated that such a pricing policy would be profit maximizing for a typical inventory-carrying store to follow. The estimated coefficients of the equation explaining the margin earned strongly support the hypothesis that this department store followed such a short-run inventory-based pricing policy. In fact, over the short run (taken to be 1 year or less), variations in the amount of inventory disequilibrium are shown to be the most important determinant of variations in the margin earned. Over longer periods of time, increases in costs other than the cost of merchandise sold are shown to significantly impact the margin earned, as would be expected.

Additionally, similarly specified equations were estimated to explain the month-to-month variance in the margin earned over the wholesale cost in each of 20 different departments within the department store. Tests of the coefficients of these estimated equations strongly support the hypothesis that a short-run inventory-based pricing policy was followed in nearly all these departments. Inventory-carrying retail stores handle the vast majority of all final sales of consumer commodities in the United States. Thus an important implication of this finding is that the rate of inflation of consumer commodity prices over the short run should be related to the condition of distribution-sector inventories. If distribution-sector inventories are excessive relative to their optimum levels (as they tend to be at the beginnings of recessions), we would expect consumer commodity inflation to decrease, ceteris paribus, as stores cut their prices (margins) in order to sell off the excess inventory. If distribution-sector inventories are low relative to their optimum levels, we would expect the rate of consumer commodity inflation to increase, ceteris paribus, as a result of stores increasing their margins in accordance with their short-run inventory-based pricing policies. During severe shortages, such as the ones which occurred in recent years for gasoline and antifreeze, this increasing of margins in response to tight inventories was particularly noticeable.

Actually there is a fair amount of empirical evidence scattered in the

2. Contrary to what seems to be widely shared opinion, the margin earned as a percentage of the wholesale cost varied considerably over time. Data on this variation will be presented in the next section.

literature which supports the hypothesis that short-run inventory-based pricing policies are widely followed. Cyert and March (1963), in their chapter reporting on their in-depth study of the operations of several departments of a department store, state that the majority of markdowns (reductions in the retail price) are accounted for by three general, excessive inventory situations. At a much more aggregate level, Charles Schultze and Joseph Tryon (1965), as part of the Brookings Model, regressed a value-added price (gross margin per unit of real output distributed) for the distribution sector on unit labor costs and on the deviation from trend of the ratio of inventories to gross product originating, finding a positive and statistically significant coefficient on unit labor costs and a negative and significant coefficient on the deviation of the inventory/product ratio. Thus they found that the larger the deviation of the inventory/product ratio relative to its trend (or roughly, the more excessive were distribution-sector inventories), the lower was the margin earned by the distribution sector. This result is consistent with distribution-sector firms following short-run inventory-based pricing policies.

There is also considerable evidence that the use of short-run inventory-based pricing policies is not limited to the distribution sector. Schultze and Tryon (1965) also found that deviations from trend of the ratio of inventories to gross product originating enter significantly with negative signs in equations explaining the wholesale prices of both durable manufactured goods and nondurable manufactured goods. In contrast to retail firms, who generally use only two inventory control tools (changing the level of orders and varying the price charged), manufacturing firms can change the rate of production to help control their inventories. Although most studies of inventory behavior and production behavior have ignored the interconnections between a manufacturing firm's production, inventory, and pricing policies, several studies have not. In an early study, Mills (1962) demonstrated that higher initial inventory levels tended to depress the price charged in three manufacturing industries (southern pine lumber, cement, and pneumatic tires). Similar results were obtained by Hay (1970) for the lumber and paper industries. Mill's and Hay's models explicitly recognize that deviations from the desired inventory level are costly to firms, but they substitute out the unobservable desired inventory level before estimating their price equations. Courchene (1969), on the other hand, entered a variable measuring the deviation from the desired inventory level directly into separate equations explaining the rate of price change in six individual Canadian manufacturing industries and in overall Canadian manufacturing prices.[3] His results show that the

3. Courchene (1969) utilized estimated inventory equations to construct the variables reflecting desired or equilibrium inventory levels.

quarterly rates of inflation of output prices for total manufacturing and for five of the six industries were negatively related to the difference between actual and desired inventory levels. In fact, Courchene concluded that fluctuations in this difference were more important than changes in wages in explaining short-run price movements (Courchene 1969, p. 325). This evidence suggests that many manufacturing firms also employ a short-run inventory-based pricing policy. The offering of "rebates" to retail customers by the manufacturers of autos and appliances in response to excess inventories in the recent 1974–75 recession, and occasionally since then, also suggests that manufacturing firms employ such pricing policies.

Other than the noneconometric study by Cyert and March (1963), however, there seems to have been no studies which have examined the short-run pricing behavior of retail firms at the firm level. That is the purpose of this study. In the next section the equation specification which was estimated to explain fluctuations in the margin earned is described, and the variables utilized are discussed in detail. In Section II the estimation results for the total store are presented, and the importance of each of the independent variables is discussed. Section III presents similar estimation results for each of 20 different departments within the store. Some of the implications of these results are briefly discussed in the final section.

I. Equation and Variable Specifications

Each month a particular good may be sold at several different margins, m, over the wholesale cost, p_w. What we would like to explain is how the average margin earned fluctuates over time. We define the average actual margin, $\bar{m}$, earned on multiple sales of a good to be the average of the margins earned on each sale weighted by the proportion of total sales made at each margin. For example, if the firm earns a margin, $m_o = (p_o - p_w)$ on q_o number of sales at the initial price, p_o, and earns a margin, $m_1 = (p_1 - p_w)$ on q_1 number of sales at a marked down price, p_1, its average actual margin earned on total sales is given by the formula:

$$\bar{m} = (p_o - p_w)\frac{q_o}{q_o + q_1} + (p_1 - p_w)\frac{q_1}{q_o + q_1}. \tag{1}$$

Analogous formulas would apply to cases where sales are made at more than two different prices during the period. This average actual margin earned is a direct function of the average retail price charged during the period:

$$\bar{m} = \bar{p} - p_w. \tag{2}$$

Thus, if we can estimate an equation which explains fluctuations in the average actual margin earned, $\bar{m}$, we will have explained all fluctuations in the average retail price charged, except that caused by movements in the wholesale price. While data on the average actual margin were not available, we were able to algebraically derive from the reported operating statistics a monthly time series on the average actual margin deflated by the wholesale price, $\bar{m}/p_w$.[4] This deflated average actual margin, or equivalently the average actual margin as a percentage of the wholesale price, $\bar{m}/p_w$, fluctuates with changes in the store's overall pricing policy, as is obvious from equation (2).

Retail markets in urban areas generally are rather competitive. Individual retail stores must on average charge the competitive market price or expect to gradually lose customers to other stores.[5] In this sense, they are output price takers over the long run. Also, most independent retail firms, over both the short and long runs, tend to be price takers in buying their merchandise at wholesale either from manufacturers or from wholesalers.[6] Thus over the long run, the average margin charged as a percentage of the wholesale price, $\bar{m}/p_w$, which we shall hereafter denote as MARGIN, we would expect to be a function of the level of competitive operating costs borne by all stores handling the particular good.[7] These operating costs, OC, consist primarily of wage costs and capital costs. For the department store for

4. The following formula was utilized to calculate this deflated actual margin: $\bar{m}/p_w = GM/[(1 - MU)(\text{MARKD} + 1)]$, where GM = gross margin percentage, MU = initial markup percentage, and MARKD = percentage of sales sold at markdowns.

5. In the case where the retail market is "monopolistically competitive," each store must charge the market price on average or expect to lose customers.

6. The exception being large chains, like Sears and K-Mart, who possess considerable monopoly power in negotiating to buy huge quantities of goods from individual manufacturers.

7. Such a relationship can be derived as resulting from the maximizing behavior of a competitive firm. Nordhaus (1972) has shown that the long-run profit-maximizing price which a "neoclassical" firm will desire to charge is a function of its factor costs. E.g., if it utilizes a fixed proportions production function which is subject to constant returns to scale, $X_t = \min\left(\frac{K}{a_1}, \frac{L}{a_2}, \frac{M}{a_3}\right)$, then its optimum price is $P_t = C(a_1q_t + a_2W_t + a_3V_t)$, where C is a constant, q_t is the service cost of capital (at an annual rate), W_t is the wage rate for a unit of labor, and V_t is the cost of materials (i.e., P_w, the wholesale price). If one assumes it takes 1 unit of good held as inventory capital γ% of the year, a_2 units of labor, and 1 unit of good bought at wholesale to produce 1 unit of sales, X_t, then (letting $C = 1$): $P_t = \gamma q_t + a_2W_t + P_w$, or $P_t - P_w = \gamma q_t + a_2W_t$, or $\left(\frac{m}{P_w}\right) = \gamma\left(\frac{q_t}{P_w}\right) + a_2\left(\frac{W_t}{P_w}\right)$. Since the store's inventory is its main capital investment, the service cost of capital would be given by $q_t = P_w(r_t + \delta)$, where δ = depreciation rate and r_t = short-term interest rate in period t. Subbing this into the previous equation we get $\left(\frac{m}{P_w}\right)_t = \gamma\delta + \gamma r_t + \left(\frac{W}{P_w}\right)_t$, showing that in the long run, $\left(\frac{m}{P_w}\right)_t$ is a function of a short-term interest rate and the deflated wage level.

which we have data, these operating costs trended upward over the sample period, rising from 31% of annual sales in 1950, to 33.5% in 1957, and to 37.6% of annual sales in 1964. In terms of an equation:

$$OC(t) = \gamma_0 + \gamma_1 \text{ wages}(t) + \gamma_2 \text{ capital costs}(t). \tag{3}$$

The largest capital investment of most stores is in its inventory. In general we would expect γ_1 to be much larger than γ_2. Reflecting increases in these operating costs, the MARGIN charged on average by the department store for whom we have data trended upward over the sample period from 53.6% in 1950 to 57.6% in 1964, averaging 55.6% over the sample period. Note that a 55.6% MARGIN expressed as a percentage of wholesale cost is equivalent to a margin that is 35.7% of the retail price.

Over the short run, due to imperfect information on the part of consumers (and the transactions costs associated with search), individual retail stores possess some temporary monopoly power. By temporarily letting their MARGIN deviate from the competitive MARGIN, they can affect their expected rate of sales. In a previous paper (Irvine 1979) I have shown that inventory-carrying stores find it profit maximizing to take advantage of this monopoly power by using temporary price (MARGIN) variation to help keep their inventories near their desired levels. Namely, under a variety of different assumptions about the form of the density function of an uncertain demand function, it can be shown that inventory-carrying stores find it profit maximizing to follow a short-run inventory-based pricing policy. Such a policy requires the store to post a retail price, $p(t)$, in the upcoming period which is less than the long-run market equilibrium price, $p^*(t)$, if it finds its actual beginning of the period inventory, $I(t)$, exceeds its desired target level, $I^*(t)$; and to post a price, $p(t)$, which exceeds $p^*(t)$ if it finds, on the other hand, that its actual inventory, $I(t)$, is less than the desired level, $I^*(t)$.

If the store followed a short-run inventory-based pricing policy, we would theoretically expect to observe a systematic negative relationship between MARGIN(t) and the amount of inventory disequilibrium, $[I(t) - I^*(t)]$. Combining these short-run and long-run influences we obtain the following equation to explain the MARGIN charged in any particular period:

$$m/p_w = \beta_0 + \beta_1(OC) + \beta_2(I - I^*), \tag{4}$$

where we expect by theory that $\beta_1 > 0$ and $\beta_2 < 0$. Since data on the desired inventory level, $I^*(t)$, were not available, before we could estimate equation (4) we had to substitute for $I^*(t)$. In the inventory-investment literature, generally desired target inventory levels are assumed to be a function of the expected size of future sales.[8] We shall assume that target inventory levels are also an inverse function of the level of financial inventory-carrying costs, that is,

$$I^*(t) = \alpha_0 + \alpha_1 ES(t) + \alpha_2 \text{ (inventory-carrying costs)}, \tag{5}$$

where $ES(t)$ = expected sales over the future period. We expect a priori that $\alpha_1 > 0$ and $\alpha_2 < 0$. Now substituting equation (5) for $I^*(t)$ and equation (3) for operating costs into equation (4), we obtain (omitting time subscripts):

$$\begin{aligned}\frac{m}{p_w} = \beta_0 + \beta_1\gamma_0 + \beta_1\gamma_1 \text{ (wages)} + \beta_1\gamma_2 \text{ (capital costs)} \\ + \beta_2[I - \alpha_0 - \alpha_1 ES - \alpha_2 \text{ (inventory-carrying costs)}].\end{aligned} \tag{6}$$

Since the largest capital investment of most retail stores is their inventory, we shall assume that fluctuations in capital costs as well as inventory-carrying costs are captured by fluctuations in a short-term interest rate, r_s. Substituting and combining terms we obtain:

$$\frac{m}{p_w} = a_0 + \beta_1\gamma_1 \text{ (wages)} + (\beta_1\gamma_2 - \beta_2\alpha_2)r_s + \beta_2[I - \alpha_1 ES], \tag{7}$$

where $a_0 = \beta_0 + \beta_1\gamma_0 - \beta_2\alpha_0$.

To estimate this specification, data on expected sales in the upcoming period, $ES(t)$, are needed. Like most previous studies of inventory investment, we had to employ a structural proxy variable due to the unavailability of such data. We used an expected sales forecast commonly utilized by retailers, that is, last year's sales in the same month adjusted by the store's recent sales experience.[9] An expectations formula which reflects this type of expectations mechanism is:

$$\text{ESCM}(t) = \text{SALES}(t-12)\left\{\frac{1}{3}\left[\frac{\text{SALES}(t-1)}{\text{SALES}(t-13)} + \frac{\text{SALES}(t-2)}{\text{SALES}(t-14)} + \frac{\text{SALES}(t-3)}{\text{SALES}(t-15)}\right]\right\}, \tag{8}$$

where ESCM(t) = expected sales in the upcoming month t and SALES(t) = actual sales in month t. This formula adjusts a linear

8. See Lovell (1964), Evans (1969), and Bridge (1973) for surveys of the inventory-investment literature.

9. Cyert and March (1963, pp. 135–36) report the use of this type of sales-forecasting formula by the departments of a department store whose operations they studied in detail. Also, in personal interviews conducted with the managers of over 30 retail stores, I found that this was by far the most commonly utilized forecasting method (see Irvine 1976, chap. 6). Also, Trevidi (1973) in an econometric study of aggregate retail inventories in the United Kingdom found that a formula very similar to (8) worked very well, and Irvine (1978) found that this identical formula performed well in an econometric study of aggregate U.S. retail inventories.

extrapolation by the amount such a linear extrapolation would have been off over the previous 3 months.[10] The correlation between total store expected sales predicted by this formula, ESCM(t), and the actual realized sales is .95 over the sample period. In establishing their target inventories of most nonperishable goods, retail firms generally take into account the sales they expect to make over the next couple of months. Thus, in addition to ESCM(t), a measure of sales expected in the next month after the upcoming month, ESNM(t) was calculated by a formula identical to equation (8) except that the first term after the equal sign was replaced by SALES(t − 11). Alternatively, the sum [ESCM(t) + ESNM(t)] and ESCM(t) were employed as structural proxies for expected future sales, $ES(t)$. Both these expected sales variables and the initial inventory levels were deflated by the Department Store Price Index (published biannually by BLS).

As a measure of the short-term interest rate, we chose the prime bank interest rate, PRIMER(t), since it is the rate to which the rates on bank loans to small businesses are most closely related.[11] As an index of the wage costs borne by the store, we utilized the average hourly earnings of nonsupervisory workers employed in wholesale and retail trade deflated by the Consumer Price Index (see Appendix for sources and detailed definitions of variables utilized). This real wage variable, RWAGE(t), rose 42% over the sample period. Thus the following specification was estimated initially:

$$\text{MARGIN}(t) = a_0 + \beta_1\gamma_1[\text{RWAGE}(t)] + (\beta_1\gamma_2 - \beta_2\alpha_2)\ \text{PRIMER}(t) + \beta_2[ID(t) - \alpha_1(\text{ESN2MD}(t))] + \epsilon(t), \quad (9)$$

where $ID(t)$ = deflated beginning of month inventory level and ESN2MD(t) = sum of deflated ESCM(t) and ESNM(t).

II. Estimation Results for the Total Department Store

The MARGIN(t) charged on average across the entire store fluctuated quite a bit over the sample period. Around its mean value of 55.6% its standard deviation was calculated to be 7.8%. To explain these

10. A firm's expected sales of a good theoretically should also depend on the condition of aggregate inventories of the good in the economy. Excess aggregate inventories suggest that the firm's sales will be down in the future, while tight aggregate inventory levels suggest higher future sales for the firm. In practice, data on the condition of aggregate inventory levels are not available on a current basis and thus are of little use to firms forecasting their expected sales.

11. Theoretically the short-term interest rate entering a service cost of capital should probably be a real rate of interest, i.e., an expected rate of inflation should be subtracted from the nominal prime interest rate. However, over the 1951–64 sample period utilized there was very little inflation (on average department store prices rose 1.1% per year). Given this low rate and the absence of a measure of inflation expectations, the expected rate of inflation was assumed to be zero in this paper.

monthly fluctuations in MARGIN(t), equation specification (9) was estimated by ordinary least squares over a sample period extending from May 1951 through December 1964.[12] A heteroscedasticity correction was necessitated by the manner in which the dependent variable was derived.[13] Theoretically the value of α_1 should be approximately one.[14] The estimated coefficients of equation (9) under the assumption that $\alpha_1 = 1.0$ are reported as equation (10) in table 1. The estimated coefficient on RWAGE(t) is positive as expected and tests to be statistically different from zero at the 1% level according to a one-tailed t-test. The estimated coefficient on the prime rate is negatively signed and tests via a two-tailed t-test to be statistically different from zero at the 5.0% level. Its negative sign and size suggests that $\beta_2\alpha_2$ is considerably larger than $\beta_1\gamma_2$. The estimated coefficient on the inventory disequilibrium term, [$ID(t)$ − ESN2MD(t)], which tests to be statistically different from zero at the 5.0% level by a one-tailed t-test, is negatively signed as expected. This confirms that the store followed a short-run inventory-based pricing policy. The elasticity of MARGIN(t) with respect to this variable was calculated to be −.052. Specifications which assumed α_1 was less than one fit worse, while specifications with α_1 greater than one produced marginally better fits.

However, there is a possibility that the coefficient on [$ID(t)$ − ESN2MD(t)] may be biased downward due to possible correlation between the store's MARGIN and the price deflator used to deflate both the inventory and expected sales series. For example, to the extent increases in the store's $(\overline{m}/p_w)$ are correlated with increases in the department store price index, a spurious inverse relationship may be introduced by an inaccurate deflator. Thus to the extent the BLS

12. For estimation purposes the prime interest rate can be considered to be exogenous since it is determined primarily outside the retail sector. The real wage of nonsupervisory workers employed in wholesale and retail trade while endogenous to the retail sector can be considered as given to any individual retail store. The other independent variable is predetermined as can be seen by examining eq. (8) and realizing that $ID(t)$ is the actual beginning of the month deflated inventory level.

13. The dependent variable, MARGIN(t), as we discussed, was derived via the formula given in n. 4 from the observed monthly initial markup percentage, $MU(t)$, markdown percentage, MARKD(t), and gross margin percentage, $GM(t)$. How representative a particular monthly initial markup percentage is of the average markup applied to the store's current inventory of goods for sale depends on the size of shipment received in the tth month. If the shipment is very small the markup applied to those goods may be very unrepresentative of the average initial markup. Thus, the different monthly initial markup percentages and, in turn, MARGIN(t) through the formula of n. 4 have different-sized ϵ_t disturbance terms, i.e., $V(\epsilon_t) \neq \sigma^2$ for all t. This condition calls for a heteroscedasticity correction to be made. Both sides of eq. (9) were multiplied by the square root of the shipments received in the month. This corrects for the heteroscedasticity, weighting the months with the larger shipments more, since those observations are more accurate.

14. Models of optimum inventory policy under uncertainty for a firm, such as that developed by Mills (1962), have α_1 equal to one. On the other hand, other models imply that there are economies to scale to inventory holding, implying α_1 values less than one.

TABLE 1 Estimated Equations Explaining Monthly MARGIN Earned by the Total Department Store

Independent Variables	A Priori Expected Sign	Equation (10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	Estimated Point-of-Means Elasticities (Calculated for eq. [15] Coefficients)
Intercept		47.78	52.63	51.38	52.65	50.32	50.54	50.82	50.40	
		(4.38)	(4.12)	(4.15)	(4.16)	(4.30)	(3.96)	(3.98)	(4.04)	
Real wage	+	18.38	18.49	18.78	18.98	16.42	16.33	16.93	16.38	.36
		(7.41)	(6.27)	(6.41)	(6.49)	(6.45)	(6.12)	(6.19)	(6.23)	
Prime interest rate	?	−2.16	−1.96	−2.02	−1.99	−1.54	−1.57	−1.59	−1.60	−.11
		(1.05)	(.90)	(.92)	(.92)	(.92)	(.88)	(.89)	(.90)	
$[ID(t) - \text{ESN2MD}(t)]$	−	−.00105								
		(.00059)								
$I(t)/\text{ESN2M}(t)$	−		−4.28		−4.06		−2.43	−1.75	−2.92*	−.091
			(.94)		(1.16)		(.97)	(1.29)	(1.14)	
$I(t-1)/\text{ESN2M}(t-1)$	−				−.43			−1.04	.67*	
					(1.20)			(1.29)	(.86)	
$I(t-2)/\text{ESN2M}(t-2)$	−								−.08*	
									(.77)	
$I(t)/\text{ESCM}(t)$	−			−1.79						
				(.42)						
$[I/\text{ESN2M}]$*DJAN	−					−4.65	−2.51	−2.84	−2.41	−.094
						(1.37)	(.81)	(.91)	(.83)	
$[I/\text{ESN2M}]$*DFEB	−					−3.04				
						(1.51)				
$[I/\text{ESN2M}]$*DMAR	−					−1.80				
						(1.57)				

[I/ESN2M]*DAPR	–					−2.91				
						(1.57)				
[I/ESN2M]*DMAY	–					−2.33				
						(1.55)				
[I/ESN2M]*DJUN	–					−2.06				
						(1.45)				
[I/ESN2M]*DJUL	–					−6.18	−3.41	−3.28	−3.38	−.13
						(1.55)	(.74)	(.76)	(.75)	
[I/ESN2M]*DAUG	–					−1.51				
						(1.66)				
[I/ESN2M]*DSEP	–					−2.95				
						(1.70)				
[I/ESN2M]*DOCT	–					−2.30				
						(1.63)				
[I/ESN2M]*DNOV	–					−2.22				
						(2.47)				
[I/ESN2M]*DDEC	–					−2.72				
						(1.89)				
RHO		−.277	−.328	−.31	−.323	−.28	−.30	−.30	−.29	
R^2 (adjusted)		.864	.880	.878	.882	.890	.895	.896	.893	
D-W		2.01	2.03	2.02	2.03	2.02	2.05	2.05	2.05	
SE (adjusted)		3085	2934	2955	2950	2779	2732	2743	2759	
Sum of squared residuals (units E + 08)		15.23	13.77	13.97	13.75	11.51	11.79	11.74	11.73	

NOTES.—Estimated SEs appear in parentheses below the coefficients. Range for all specifications was May 1951 through December 1964 (164 observations), except for (13) and (16), which start in June 1951, and eq. (17), whose range begins in July 1951. Each corrected-for autocorrelation by use of an autoregressive transformation and heteroscedasticity as noted in the paper.

*These are the coefficients of a third-order, three-period Almon lag whose sum is −2.32, with a SE of 1.11.

Department Store Price Index is not representative of this particular department store, the estimated coefficient on the disequilibrium term in equation (10) may be biased. To avoid this problem, the disequilibrium term was entered in a ratio form, that is, in the form of a stock to expected sales ratio. The estimated coefficients of specification (9) with this change are reported as equation (11) in table 1. As one can see, this change resulted in a substantially improved fit while leaving the coefficients on other variables nearly the same. Estimating the equation under the alternative assumption that expected sales are measured by only ESCM(t) produces a worse fit (see eq. [12]), which suggests that the store's expected sales are better proxied by the sum of the next 2-months' sales, ESN2M(t), as originally assumed.

The large-sized, statistically significant coefficient on [$I(t)$/ESN2M(t)] in equation (11) is strong evidence that the store followed a short-run inventory-based pricing policy. The time pattern of response to inventory disequilibrium was carefully investigated. As the relatively small-sized estimated coefficient on the lagged inventory-to-expected-sales ratio in equation (13) indicates, however, most of the price response to inventory disequilibrium seems to occur immediately.[15] The possibility that the store's response to inventory disequilibrium might differ seasonally was also explored in detail. For example, it was thought that excess inventories in October, just prior to the peak Christmas selling season, might evoke considerably less price cutting than the same amount of excess inventories in January or February, since sales tend to be much slower during the winter. It was also recognized that many retail stores hold "sales" at traditional times of the year, independent of the condition of their inventories. To test these possibilities, a specification which allowed the coefficient of [$I(t)$/ESN2M(t)] to take on a different value in each month was estimated.[16] As one can observe, the fit of this specification (eq. [14]) is considerably better. Also, all the estimated monthly coefficients on the stock-to-sales ratio take on the expected negative sign, suggesting that a short-run inventory-based pricing policy is utilized every month. These coefficients generally fall into the -2 to -3 range, except for the January coefficient of -4.65 and July coefficient of -6.18. These coefficient estimates are very reasonable in light of the fact that January and July tend to be the 2 months in which storewide "clearance sales" are traditionally held. In these months, margins are cut more in response to excess inventories than they are the rest of the year, ceteris paribus.

15. The equation was also estimated with an Almon distributed lag on the stock-to-sales ratio. Generally the coefficients of terms past the current month were insignificant and the fit was not improved.

16. This was accomplished by entering [$I(t)$/ESN2M(t)] multiplied by 12 separate monthly dummy variables which take on the value 1 in only 1 month each year.

The results above suggest that a better specification would be only to estimate separate slope coefficients on $[I(t)/\mathrm{ESN2M}(t)]$ for January and July. The fit of such a specification (eq. [15]) is even better as indicated by the estimated standard error of the equation. A Chow test (F-test) was done on the null hypothesis that the coefficients on $[I(t)/\mathrm{ESN2M}(t)]$ are the same, excepting those for January and July.[17] The null hypothesis could not be rejected. As a further test of whether specification (15) captured all the seasonal effects, we estimated it with 11 monthly dummy variables added. A Chow test failed to reject the hypothesis that the coefficients of the 11 dummy variables were zero, thereby indicating that further seasonal adjustment of specification (15) is statistically insignificant. This refutes any suggestion that changes in MARGIN(t) might be the result of seasonal changes in the composition of the store's inventory.[18]

Equation (16) adds a lagged stock to expected sales term to the best-fitting seasonal specification (15) to once again explore the possibility of a lagged response to inventory disequilibrium. As one can observe, the statistical insignificance of the term's estimated coefficient and the deterioration in fit (as measured by the standard error of the regression) of this equation suggests again that most of the response is immediate. Equation (17), in which the stock-to-sales ratio was entered as a three-period Almon lag, confirms this. The estimated sum of the lag coefficients (-2.32) differs little from the current period response to inventory disequilibrium (-2.43) estimated in equation (15). Thus equation (15) we take to be the best specification for explaining the monthly variance of the MARGIN(t) charged by this department store.

All of the estimated coefficients of equation (15) are of the a priori expected sign and are statistically significant. The estimated point-of-means elasticities with respect to the independent variables calculated from the coefficients of equation (15) are reported in the right-hand column of table 1. The estimated elasticity with respect to RWAGE(t) of (.36) is quite reasonable in light of the fact that operating expenses averaged about 34.7% of sales over the sample period, and labor costs presumably accounted for the vast majority of operating expenses. This result simply indicates that as expected, over the long run as operating costs rise relative to the cost of the goods sold, we observe increases in the MARGIN charged. The negatively signed, large-sized

17. To do this test, eq. (15) was treated as the constrained regression and eq. (14) was treated as the unconstrained regression. Then $[(\mathrm{ESS}_R - \mathrm{ESS}_U)/\mathrm{ESS}_U]\,[(n-k-1)/d] \sim F_{d,n-k-1}$, where n = number of observations, k = number of coefficients in unconstrained regression, and d = difference in number of coefficients. The left hand side yields a $F = .40$, much less than that needed to reject the null hypothesis.

18. If, e.g., the store's inventory was composed of more low MARGIN items in one particular season or month, those monthly dummy variables would have been significant. They were not, which allows us to conclude that for this store, seasonal variations in MARGIN(t) are explained only by fluctuations in the variables included in eq. (15).

coefficient on the prime interest rate suggests that this store's target inventory is reasonably sensitive to fluctuations in the financial cost of carrying the inventory.

The most striking result, however, is the size of elasticities with respect to $[I(t)/\mathrm{ESN2M}(t)]$. For normal months it is $(-.091)$, and in the traditional clearance sale months of January and July, its value is more than double that. This indicates that not only does this store employ a short-run inventory-based pricing policy, but inventory disequilibrium has an important impact on the prices charged (MARGIN earned) by the store. Should the inventory-to-expected-sales ratio be as much as 1.0 above its sample period average of 2.09, in a normal month we would expect the MARGIN(t) to be lower by about 8%. If such excess inventories occurred from, say, a poor Christmas sales season, we would expect cuts in price twice that size in January. The size of the elasticity of MARGIN with respect to this inventory-to-expected-sales ratio thus confirms that the short-run inventory-based pricing policy is economically as well as statistically important in explaining fluctuations in MARGIN(t).

In addition, it would be nice to know how important variation in the firm's inventory level around its optimum level is in explaining fluctuations in the average actual margin earned. In other words, what percentage of the variance of MARGIN(t) is explained by the store's use of its short-run inventory-based pricing policy? Although it is an interesting question, unfortunately there is no good way to answer it completely. One measure of the contribution of individual independent variables is known in the literature as a "beta coefficient," which can loosely be interpreted as the percentage of the variance explained by the independent variable.[19] However, they suffer from the defect that their sum is not constrained to add up to 100%. Nevertheless, for lack of a better measure, we calculated beta coefficients for each of the independent variables in equation (15). Over the sample period the respective beta coefficients are .21 for RWAGE(t), .15 for PRIMER, and .12 for $[I(t)/\mathrm{ESN2M}(t)]$ in normal months (and more than double .12 in January and July). These indicate that over the sample period, fluctuations in RWAGE(t) and the store's use of a short-run inventory-based pricing policy explain similar amounts of variance in MARGIN(t). These comparisons understate the relative amount of variance explained by fluctuations in $[I(t)/\mathrm{ESN2M}(t)]$ over shorter periods of time, however, since its variance is relatively much larger than that of RWAGE(t) over short periods such as a year.[20] This is

19. See Goldberger (1964, pp. 197–98) for a discussion of beta coefficients. The beta coefficient of an independent variable equals the estimated regression coefficient on that independent variable multiplied by the standard deviation of that independent variable and divided by the standard deviation of the dependent variable.

20. Beta coefficients were calculated for RWAGE and $[I(t)/\mathrm{ESN2M}(t)]$ for each calendar year within the sample period. The average within-year beta coefficient was .032 for RWAGE and .135 for $[I(t)/\mathrm{ESN2M}(t)]$ for the total store. This reduction in the

because RWAGE(t) is largely a trend variable which displays minimal seasonal variance. Thus we can conclude that the store's use of a short-run inventory-based pricing policy is more important in explaining short-run movements in MARGIN(t) than are fluctuations in wage costs.

III. Estimation Results for Individual Departments

Separate equations for 20 representative departments with the longest sample periods were estimated to explain the month-to-month variance in each department's margin as a percentage of the wholesale price, $\text{MARGIN}_i(t)$. On the bottom two lines of table 2 the means and standard deviations of these $\text{MARGIN}_i(t)$ are listed. As one can observe, these statistics indicate that there was a large amount of variance in the $\text{MARGIN}_i(t)$ charged and that most departmental $\text{MARGIN}_i(t)$ display more variance relative to their mean values than does the store as a whole.

The specification given by equation (9) with the inventory disequilibrium term entered as a stock-to-sales ratio was initially estimated for each of the 20 departments. As with the equation explaining the MARGIN(t) charged by the total store, it was thought necessary to estimate for each department alternative specifications which (1) used the alternative stock-to-expected-current-month-sales ratio, (2) explored the possibility of different seasonal responses to inventory disequilibrium, and (3) explored the possibility of a lagged response to inventory disequilibrium. Rather than tailor fit each of these 20 equations, first a specification substituting $[I_i(t)/\text{ESCM}_i(t)]$ for $[I_i(t)/\text{ESN2M}_i(t)]$ was estimated. Then, using for each department the respective inventory-to-sales ratio which produced the best fit, other specifications—including lagged values of the inventory-to-sales ratio and the inventory-to-sales ratio multiplied by January and July dummy variables—were estimated. These lagged values and seasonal dummy terms were dropped from the final specification of each department's equation if their individual estimated coefficients had t-statistics less than 1.0 and if dropping them improved the fit of the equation. Both seasonal terms were either retained or dropped. The estimated coefficients of the best-fitting equation for each department are reported in table 2.

In accordance with a priori expectations, the estimated coefficient on RWAGE(t) was positive in 17 out of 20 departmental equations. The

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beta for RWAGE is the result of the fact that around a mean of 1.043, RWAGE had an average yearly standard deviation of only .0113, which is much smaller than its standard deviation of .1035 over the entire sample period. On the other hand, around a mean of 2.09, $[I(t)/\text{ESN2M}(t)]$ had an average yearly standard deviation of .357, which is about the same size as its entire sample period standard deviation of .398 calculated around the same mean.

TABLE 2 Estimated Equations Explaining Monthly MARGIN$_i(t)$ Earned by Each Department

Independent Variables	Jewelry	Handbags and Small Leather Goods	Bras and Corsets	Women's Hosiery	Women's and Misses Coats and Suits
Intercept	53.09	20.30	60.01*	36.44	15.43
	(6.04)	(5.02)	(3.98)	(3.55)	(16.63)
Real wage	28.33*	50.94*	19.78*	28.10*	48.28*
	(10.06)	(7.44)	(4.65)	(5.50)	(24.65)
Prime interest rate	−2.27	−2.25*	−1.35*	−.40	−3.35
	(1.45)	(1.14)	(.71)	(.79)	(2.94)
I/ESCM			−.80*	−.70*	−.89
			(.47)	(.35)	(.56)
[I(−1)/ESCM(−1)]			−.58		
			(.46)		
(I/ESCM) · DJAN			.10		−1.91
			(.27)		(1.36)
(I/ESCM) · DJUL			−.58*		−3.36*
			(.27)		(.57)
I/ESN2M	−.60	−.31			
	(1.05)	(1.45)			
[I(−1)/ESN2M(−1)]		−2.63*			
		(1.15)			
(I/ESN2M) · DJAN	−5.60*	−6.31*			
	(.94)	(.96)			
(I/ESN2M) · DJUL	−6.11*	−6.12*			
	(1.14)	(1.13)			
RHO	−.22	.04	.02	−.04	.17
R^2 (adjusted)	.910	.940	.966	.937	.738
D-W	2.04	2.00	1.98	2.00	1.93
SE (adjusted)	558.1	358.8	317.2	334.3	1127
Range	51/5–64/12	51/6–64/12	51/6–64/12	51/5–64/12	51/5–62/12
Observations (N)	164	163	163	164	140
Sum of squared residuals (units E × 10^6)	49.21	20.08	15.70	17.88	170.10
M MARGIN$_i(t)$	70.29	58.67	70.05	62.53	47.49
SD MARGIN$_i(t)$	14.64	9.50	5.32	5.13	16.71

NOTE.—All equations estimated by ordinary least squares. Estimated SEs appear in the parentheses below each coefficient.
*Statistically different from zero by a one-tailed t-test at the 5% level.

TABLE 2 (continued)

Independent Variables	Women's and Misses Dresses	Women's Sportswear Blouses and Skirts	Girls' Wear	Men's Clothing	Men's Furnishings
Intercept	30.33	31.54	52.83	−16.16	51.41
	(4.79)	(4.97)	(4.59)	(11.34)	(11.90)
Real wage	6.18*	34.33*	10.97	72.05*	21.93
	(7.64)	(7.71)	(7.08)	(10.99)	(18.09)
Prime interest rate	−.069	−1.89*	−1.29	−.69	−1.48
	(1.05)	(1.12)	(1.06)	(2.67)	(2.79)
I/ESCM		−.41	−1.25*	−.17	
		(.63)	(.39)	(.24)	
[*I*(−1)/ESCM(−1)]		−1.21*	−.68*		
		(.61)	(.33)		
(*I*/ESCM)·DJAN		−3.22*	−3.30*	−2.07*	
		(.50)	(.39)	(.33)	
(*I*/ESCM)·DJUL		−3.12*	−1.33*	−2.18*	
		(.44)	(.32)	(.43)	
I/ESN2M	−1.46				−3.50*
	(2.14)				(1.22)
[*I*(−1)/ESN2M(−1)]	−4.28				
	(1.87)				
(*I*/ESN2M)·DJAN	−5.95*				−3.30*
	(1.26)				(1.21)
(*I*/ESN2M)·DJUL	−9.79*				−2.22
	(1.62)				(1.44)
RHO	−.10	−.08	−.017	.002	−.07
R^2 (adjusted)	.858	.899	.924	.958	.695
D-W	2.02	2.00	2.02	1.98	2.01
SE (adjusted)	676.8	616.7	450.1	882.8	1695
Range	51/6–64/12	51/6–64/12	51/6–64/12	55/7–64/12	51/5–64/12
Observations (*N*)	163	163	163	114	164
Sum of squared residuals (units E × 10^6)	71.45	59.32	31.61	84.16	453.8
M $MARGIN_i(t)$	48.95	52.70	48.63	57.39	60.34
SD $MARGIN_i(t)$	8.14	10.23	9.02	17.02	33.75

TABLE 2 (continued)

Independent Variables	Boy's Wear	Silks and Other	Linens and Domestics	Toilet Articles	Draperies and Curtains
Intercept	35.84	56.05	32.89	49.25	64.54
	(6.38)	(7.08)	(6.56)	(5.16)	(5.30)
Real wage	33.74*	11.35	19.74*	14.66*	13.63*
	(10.29)	(11.23)	(9.90)	(7.79)	(8.14)
Prime interest rate	−2.06	−.33	.09	−.49	−2.52*
	(1.51)	(1.66)	(1.37)	(1.17)	(1.18)
I/ESCM	−.81*	−1.09*		−.70*	
	(.38)	(.47)		(.39)	
[*I*(−1)/ESCM(−1)]	−.42				
	(.35)				
(*I*/ESCM)·DJAN	−2.22*	−.84*			
	(.52)	(.42)			
(*I*/ESCM)·DJUL	−.65	−.55			
	(.40)	(.43)			
I/ESN2M			−.73		−.52
			(.81)		(.68)
[*I*(−1)/ESN2M(−1)]					−1.16*
					(.66)
(*I*/ESN2M)·DJAN			−1.03		−1.02*
			(.98)		(.43)
(*I*/ESN2M)·DJUL			−1.35		−1.30*
			(1.25)		(.58)
RHO	−.23	−.05	−.11	−.17	0
R^2 (adjusted)	.884	.872	.824	.904	.942
D-W	2.03	1.99	2.01	2.05	1.99
SE (adjusted)	752.0	645.8	774.4	617.4	592.9
Range	51/6–64/12	51/5–64/12	51/5–64/12	51/5–64/12	51/6–64/12
Observations (*N*)	163	164	164	164	163
Sum of squared residuals (units E × 10^8)	88.22	65.89	94.75	60.99	54.84
M MARGIN$_i(t)$	56.10	62.92	53.64	61.84	63.76
SD MARGIN$_i(t)$	26.54	15.15	17.01	23.62	6.98

NOTE.—All equations estimated by ordinary least squares. Estimated SEs appear in the parentheses below each coefficient.
*Statistically different from zero by a one-tailed t-test at the 5% level.

TABLE 2 (continued)

Independent Variables	China and Glassware	Luggage	Furniture	Floor Coverings	Major Appliances
Intercept	40.60	58.00	98.25	85.30	93.71
	(15.00)	(14.88)	(7.60)	(6.62)	(9.06)
Real wage	27.87*	26.10	−30.49*	−33.20*	−30.12*
	(15.09)	(21.89)	(11.49)	(9.53)	(13.58)
Prime interest rate	−.99	−4.54	−.05	.66	−6.36*
	(2.18)	(3.27)	(1.61)	(1.52)	(2.03)
I/ESCM	.19	−.41		−.41	.34
	(.24)	(.27)		(.30)	(.26)
[*I*(−1)/ESCM(−1)]					
[*I*/ESCM) · DJAN	−1.45*			−1.09*	−1.42*
	(.26)			(.29)	(.40)
(*I*/ESCM) · DJUL	−.88*			−.52	−.02
	(.27)			(.33)	(.34)
I/ESN2M			.07		
			(.66)		
[*I*(−1)/ESN2M(−1)]					
(*I*/ESN2M) · DJAN			−2.88*		
			(.66)		
(*I*/ESN2M) · DJUL			−.68		
			(.86)		
RHO	−.26	−.07	−.07	.01	.32
R^2 (adjusted)	.917	.629	.895	.895	.826
D-W	2.01	1.98	2.00	1.98	1.95
SE (adjusted)	554.6	854.2	1418	808.5	897.8
Range	57/7–64/12	51/5–64/12	51/5–64/12	51/8–64/12	51/5–64/12
Observations (*N*)	79	164	164	161	164
Sum of squared residuals (units E × 10^6)	22.45	116.7	317.5	10.13	127.4
M $MARGIN_i(t)$	67.81	66.98	64.03	49.48	36.30
SD $MARGIN_i(t)$	9.54	32.89	10.61	12.17	13.26

three negatively signed coefficients occurred in departments whose salesmen tend to be paid on a commission basis, suggesting that an average hourly earnings variable is not an appropriate measure of labor costs in these departments. Of the positively signed coefficients, 12 test to be statistically different from zero by a one-tailed t-test at the 5% level. The point-of-means elasticity values of all the departmental $\text{MARGIN}_i(t)$ with respect to each independent variable are reported in table 3. The elasticity estimates with respect to RWAGE(t) are quite substantial, indicating that fluctuations in labor costs have an important impact on departmental margins. The relative sizes of the estimated elasticities for the different departments also seem reasonable. As labor costs rise, economic theory would lead us to expect the store to substitute away from labor inputs. However, the possibilities for substitution vary depending on the department. The departments that require a lot of "waiting on the customer" would a priori seem to have the lowest elasticities of substitution, thus requiring that more of the increased labor costs be passed to the customer in the form of higher margins. This pattern is evident from table 3. Two of the departments requiring the most customer service, men's clothing and ladies' coats and suits, exhibit the highest estimated elasticities with respect to RWAGE(t). The next highest elasticity was obtained for the handbags and small leather goods department, a department which must have an attendant to prevent pilferage. Generally the clothing departments had higher estimated elasticities with respect to RWAGE(t) than the other departments, which are more easily adaptable to self-service arrangements.

Of the estimated coefficients on the prime interest rate, 18 are negatively signed. Such a sign pattern is consistent with the negatively signed estimated coefficient on the prime rate in the total store MARGIN(t) equation reported earlier. These coefficients suggest that the store's target departmental inventory levels are sensitive to fluctuations in financial inventory carrying costs and that a short-run inventory-based pricing policy is followed in most of the store's departments.

The use of short-run inventory-based pricing policies in nearly all of the departments is evident from the estimated coefficients on the stock-to-expected-sales ratios. Of these 61 estimated coefficients, 57 are negatively signed in accordance with a priori expectations. The four positive coefficients are statistically insignificant and occur in equations which have two other estimated coefficients on stock-to-sales ratios that are negatively signed. On the other hand, 36 of the 57 negatively signed coefficients test to be statistically different from zero by a one-tailed t-test at the 5% level. Of the 20 equations, 18 have at least one negatively signed coefficient on a stock-to-sales ratio which tests to be statistically different from zero. For 17 of the 20 departments the best-fitting specification was one which allowed the response of $MARGIN_i(t)$ to inventory disequilibrium to be greater in the traditional clearance sale months of January and July. In 12 of these 17 departments, at least two of the coefficients on the stock-to-sales ratio test to be statistically different from zero by a one-tailed t-test at the 5% level. On the other hand, lagged values of the inventory-to-sales ratio entered significantly in only a third of the departmental equations, confirming that most of the price response to inventory disequilibrium occurs immediately within 1 month. In five of the ladies clothing departments and in the boys' wear and in the draperies and curtains department, the response is spread over 2 months.[21] These results establish that inventory disequilibrium is statistically quite significant in explaining fluctuations in the $MARGIN_i(t)$ earned over time in nearly all of the departments.

The fact that fluctuations in departmental stock-to-expected-sales ratios are economically important to the explanation of the departmental $MARGIN_i(t)$ is demonstrated by the relatively large-sized elasticities reported in table 3 for these stock-to-sales variables. As one can observe, these point-of-means elasticities of $MARGIN_i(t)$ with respect to the respective stock-to-sales ratios vary considerably across the different departments. However, this variation in elasticity size takes on a very reasonable pattern. Those departments with higher nonfinancial inventory carrying costs (mainly due to style-change depreciation in the case of clothing) exhibit the largest elasticities with respect to the stock-to-sales ratios. This observation that the $MARGIN_i(t)$ of the departments with the highest nonfinancial inventory-carrying costs are the most responsive to inventory disequilibrium is in accordance with what economic theory would predict, ceteris paribus. Overall, these estimated elasticities strongly suggest that this typical small department store followed a short-run inventory-based pricing policy in nearly all its departments.

IV. Summary and Implications

The estimation results obtained for this typical small department store provide strong econometric evidence that the store's pricing behavior was significantly influenced by its use of a short-run inventory-based pricing policy. If the use of such pricing policies by inventory-carrying stores is widespread, as theory suggests it should be, then we would expect the rate of consumer commodity inflation to be influenced by the condition of distribution-sector inventories. Excess aggregate distribution-sector inventories (which typically appear around the be-

21. Inventory-to-sales ratios lagged more than 1 month were tried and dropped because of their insignificant estimated coefficients.

TABLE 3 **Point-of-Means Elasticities of $MARGIN_i(t)$ with Respect to Stock-to-Expected-Sales Ratio and Real Wage**

Department	RWAGE	Stock-to-Expected-Sales Ratio: After 1 Month	Stock-to-Expected-Sales Ratio: After 2 Months	Add to This the Following Extra Response If It's: January	Add to This the Following Extra Response If It's: July
Jewelry	.43	−.016		−.146	−.160
Handbags and small leather goods	.93	−.008	−.080	−.172	−.166
Bras and corsets	.30	−.046	−.079	.006	−.033
Women's hosiery	.48	−.035		0	0
Women's and misses' coats and suits	1.06	−.061		−.131	−.231
Women's and misses' dresses	.57	−.036	−.142	−.148	−.243
Women's sportswear, blouses and skirts	.70	−.028	−.110	−.218	−.211
Girls' wear	.24	−.101	−.156	−.265	−.107
Men's clothing	1.41	−.020		−.244	−.257
Men's furnishings	.39	−.154		−.145	−.098
Boys' wear	.64	−.077	−.117	−.212	−.062
Silks and other fabrics	.19	−.084		−.065	−.042
Linens and domestics	.39	−.029		−.041	−.097
Toilet articles	.25	−.049		0	0
Draperies and curtains	.23	−.024	−.078	−.047	−.060
China and glassware	.46	.026		−.199	−.121
Luggage	.42	−.045		0	0
Furniture	−.51	.004		−.152	−.035
Floor coverings	−.72	−.049		−.129	.079
Major appliances	−.89	.041		−.090	−.062
Total department store	.36	−.091		−.094	−.130

ginning of each recession) should cause consumer commodity inflation rates to moderate, ceteris paribus. However, according to estimates obtained in another paper (Irvine 1978), the retail sector tends to restore actual inventories to their optimum levels rather quickly (within about 3 months for nondurable goods and within 6 months for durable goods). Thus the dampening effect excess retail inventories have on the rate of consumer commodity inflation probably tends to be of rather short duration except in very deep unanticipated recessions.[22]

When aggregate distribution-sector inventories are less than their target values, we would expect to observe a higher rate of consumer commodity inflation, ceteris paribus. Since periods of tight retail inventories tend to occur just prior to business cycle peaks (e.g., 1973), the use of short-run inventory-based pricing policies worsens the

22. Of course, the presence of excess manufacturing sector inventories and the possible use of a short-run inventory-based pricing policy by manufacturers may also dampen consumer commodity inflation (as well as production rates!).

inflation problems associated with boom periods. Tight inventory levels may persist for reasonably long periods of time since the ability of the distribution-sector firms to restore their inventories to their target levels is limited by the production schedules of manufacturers over which individual stores have little, if any, control. The empirical importance of inventory disequilibrium on the aggregate rate of inflation of consumer commodities is a subject of my current research.

Another important implication of the finding that inventory-carrying stores do seem to follow short-run inventory-based pricing policies is that competitive retail markets for particular goods orgainized by these inventory-carrying stores will be characterized by a distribution of actual prices around some average market price. This is because in any given period, some stores in response to their individual excessive inventory levels will be charging less than the average market price, while other stores will be charging more than the average market price in response to their tight individual store inventory levels of the particular good. As Rothschild (1973) noted in his article surveying the emerging literature on market operation under imperfect information, the models to date have not yet yielded a definite conclusion about whether market equilibrium will be characterized by a single price or a distribution of prices.[23] In a world with finite delivery times and where individual store sales cannot be forecast with certainty, individual store inventory disequilibrium will always exist even when the market is in some sort of long-run equilibrium. This implies that because stores are following short-run inventory-based pricing policies, a distribution of prices around the average market price will exist even when the market is in long-run equilibrium.

Appendix

Variable Definitions and Sources

The MBR reports—published by the Bureau of Business Research, Graduate School of Business Administration, University of Michigan—contain operating data by department for a typical small department store from February 1950 through January 1965. The bureau collected operating statistics from 8 to 10 (depending on the year) "noncompeting, independently owned department stores that

23. Recent theoretical work by Carlton (1977, 1978) and Gould (1978) suggests that in a competitive market where consumers' utilities are dependent on both a product's price and its availability, long-run equilibrium will be characterized by a distribution of prices. In order to offer low shortage probabilities, some firms will choose to stock large inventories and to charge high equilibrium prices, while other firms will offer lower prices and lower availability by having smaller target inventories. As the papers cited suggest, the equilibrium distribution of firm target inventory levels and price levels depends on the assumptions one makes about the market process.

Variable Symbol	Variable Description	Sources of Data
$MARGIN_i(t)$	Average margin earned in month t in ith department as a percentage of the wholesale cost of the goods sold	MBR
$I_i(t)$	Beginning of the month inventory held by ith department in current dollars	MBR
$SALES_i(t)$	Actual sales of ith department in month t	MBR
AHERWW(t)	Average hourly earnings of nonsupervisory workers employed in retail and wholesale trade	E&E
CPI(t)	Consumer Price Index (all items)	BLS
RWAGE(t)	AHERWW(t)/CPI(t) based at 1960 equals 100	. . .
PRIMER(t)	Prime bank interest rate	FRB
DPI(t)	Department Store Price Index	BLS

SOURCES.—E&E = "Employment and Earnings 1909–72," BLS Bulletin 1319-9; BLS = U.S. Government, Department of Labor, Bureau of Labor Statistics; FRB = *Federal Reserve Bulletin* (various issues); and MBR = Michigan Business Reports (nos. 21, 23, 27, 30, 38, 45, and 50), *Departmental Merchandising Results in Small Department Stores*, by Edward Gault.

supply to their customers all the services usually given by service stores. All stores are located in the Great Lakes region, and all do the bulk of their business in medium and better-than-medium quality merchandise. The annual sales volume of these stores ranges from $3 million to $6 million (1962 dollars)" (Gault, no. 45, p. 1). In the 1961–62 volume we find the following additional description of the sample:

> These small department stores, with from $3 to $6 million in sales volume, are usually located in cities with populations from 50,000 to 100,000 and retail market areas with populations upward to 250,000. They are located in the downtown retail districts of these cities, and although they have no branches in shopping centers they may own and operate stores or branches in the downtown districts of nearby smaller cities or towns. In general, these stores may be described as old-line, full-service department stores. "Old-line" refers to the fact that all the merchants have been in business for fifty years or more, that many of their customers came to them before World War II, and that by and large they are continuing many prewar practices. They provide full services of credit, delivery, and acceptance of merchandise returns from unsatisfied customers. On the other hand, these merchants operate up-to-date stores with open displays and modern lighting and fixtures, and they keep their buildings in good condition. They are vigorous merchandisers and tough competitors. [Gault, no. 45, p. 1]

From each of these small department stores the bureau collected, for each department within the store, monthly data on the ratio of sales this month to the same month the previous year, each month's sales as a percentage of annual sales, each month's inventory-to-sales ratio, the percentage of sales sold each month at marked-down prices, year-to-date original markup, and year-to-date gross margin. Also on an annual basis, the dollar sales, stockturn, stock-shortage percentage, and average purchase discount was collected. The bureau then calculated the median across the 8–10-store sample, which it then published as representative of the typical value of that data series observation. When the data for a department reported to the bureau was inadequate or when the figures reported did not represent the typical performance of the group of stores supplying the data, the bureau omitted publishing the data for the particular department for that particular year. This screening of the data by the bureau is good in the sense that it assures us that the data is representative of a typical small department store's operating results. On the other hand, the screening meant that the data from some departments was not reported every year. However, from these reports 15 consecutive year-long time series (1950–64) were obtained for 17 different departments and for the total owned store. Additionally, three other departments were utilized for sample periods ranging from 9 to 13 years of monthly data. As these 20 departments represent all important merchandise categories and on average accounted for over 64% of the total sales and over 68% of the store's total inventory, the results for them should be representative of the entire store. Equations were not estimated for any of the other departments.

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