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INFLATIONARY EXPECTATIONS AND PRICE SETTING BEHAVIOR

by

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Inflationary Expectations and Price Setting Behavior

ABSTRACT

This paper tests for the existence of expectational effects in very disaggregate price equations. Price equations are estimated using monthly data for each of 40 products. The dynamic specification of the equations is also tested, including whether the equations should be specified in level form or in change form. Two expectational hypotheses are used, one in which expectations of the aggregate price level are a function of the past values of the price level and one in which expectations are rational. Under the first hypothesis the lag length is estimated along with the other parameters, and under the second hypothesis the lead length is estimated along with the other parameters.

The results strongly support the hypothesis that aggregate price expectations affect individual pricing decisions. The results do not discriminate very well between the level and change forms of the price equation, although there is a slight edge for the level form. The lag and lead lengths are not estimated precisely, but in most cases the lag length is less than 30 months and the lead length is less than 5 months.

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I. Introduction

It is often said that expectations of future prices may affect current prices. If a firm expects that its competitors are going to raise their prices, the firm may raise its own price. In the standard monopolistic competition model, an increase in the prices of a firm's competitors shifts out the demand curve facing the firm, as consumers shift away from the higher price competitors, which increases the firm's profit maximizing price. Therefore, if a firm expects that its competitors are going to raise their prices, this shifts out the expected demand curve that it faces, which leads it to raise its own price. If all firms are behaving in this way, everyone will be raising their prices because they expect that all others are, and in this way expectations can become self fulfilling. Because of this, it is argued, inflation may be difficult to stop quickly. Expectations need to be changed, and this may take a long time.

An important empirical question is whether there is anything to this story? This paper tries to answer this question by estimating expectational effects in very disaggregate price equations. Monthly price data for 40 products have been collected, and price equations are estimated for each of these products. Expectational effects are examined by adding an aggregate price expectations variable to the equations. Various specification tests of the price equations are also performed, including a test of whether the equations should be specified in level form or in change form. The use of the highly disaggregate data for these tests may allow more confidence to be placed on them than on similar tests using aggregate data.

Two expectational hypotheses have been used regarding expectations of the aggregate price variable (PA). The first is that the expected future values of PA are a function of its past values. In this case the coefficients are assumed to lie on a linear polynomial with an end point constraint of zero at lag length q. q is estimated along with the other parameters, and the standard error of the estimate of q is computed along with the standard errors of the other estimated parameters. The method for estimating q and its standard error is discussed in Andrews and Fair (1989). Estimating the lag length avoids misspecification from picking an incorrect lag length and allows the data to indicate how far back agents look in forming their expectations (under the assumption that the first expectational hypothesis is valid). Estimating the standard errors of the lag-length estimates allows one to see how much confidence to place on the particular estimated lengths.

The second expectational hypothesis is that expectations are rational. In this case the coefficients of the expected future values that enter the equation are assumed to lie on a linear polynomial with a constraint of zero at lead length r. r is estimated along with the other parameters, and the standard error of the estimate of r is computed along with the other standard errors. The method for estimating r and its standard error is also discussed in Andrews and Fair (1989). The method is a combination of Hansen's (1982) method of moments, Almon's (1965) polynomial distributed lag (PDL) technique, and the adjustments that are needed to allow r to be estimated. In this case polynomial distributed <u>leads</u> are estimated instead of polynomial distributed lags. An estimate of r is an estimate of the length ahead that expectations matter for current decisions.

The tests that were performed are discussed in Section II; the data and variables are explained in Section III; and the results are presented in Section IV.

II. The Tests

A standard price equation contains cost variables and demand-pressure variables. In the monopolistically competitive model one can consider the cost variables as representing the marginal cost (MC) curve of the firm. An increase in the price of some input shifts the MC curve up and leads the firm to raise its price. The demand curve facing the firm shifts when general industry demand conditions change and when the prices charged by other firms in the industry change. The demand-pressure variables can be thought of as trying to pick up the effects of general demand conditions on price setting behavior. An increase in industry demand shifts the demand curve facing the firm out and leads the firm to raise its price.

Let P_t denote the log of the price of a firm's good in period t, and let X_t denote a vector of cost and demand-pressure variables that may affect P_t.[1] Write the price equation as

(1) $$P_t = X_t\beta + u_t \quad , \; t = 1,\ldots,T \; ,$$

where β is a vector of parameters to be estimated and u_t is an error term.

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[1]The price, wage, and cost variables are taken to be in logs in the empirical work. For ease of exposition, P_t will simple be referred to as the price rather than the log of the price, and similarly for the wage and cost variables.

The aim of this paper is to try to test for expectational effects in an equation like (1). Let PA^e_{t+j} be the firm's expectation of the log of the aggregate price level in period t+j ($j \geq 0$), the expectation being made at the beginning of period t (before information for period t is available). Adding PA^e_t, PA^e_{t+1}, etc. to equation (1) provides a test of whether expectations matter. If X_t adequately captures all the non expectational variables that affect P_t and if expectations don't matter, then PA^e_t, PA^e_{t+1}, etc. do not belong in the equation and should not be statistically significant. If they are significant, this is evidence in favor of the existence of expectational effects.

The danger with this approach is that one may have left out important explanatory variables from X_t that are correlated with the PA^e_{t+j} variables. Too much will then be attributed to the expectations variables. To guard against this, many variables have been included in X_t. The aim has been to err on the side of too many variables rather than too few. As discussed in the next section, more than one demand-pressure variable has been included in each equation and a number of cost variables have been included. In addition, a linear time trend and seasonal dummy variables have been included.[2] Finally, a fairly rich dynamic specification has been used for some of the equations. Because of the large number of variables included in X_t, some highly correlated with others, many of the individual parameters are not estimated precisely. This is not, however, of direct concern here. The concern here is simply whether the PA^e_{t+j} variables have independent

[2]Even though most of the variables in the estimated equations are seasonally adjusted, the seasonal dummies were included to pick up possible seasonal effects not captured in the data. This procedure is consistent with the theme of erring on the side of too many rather than too few variables in X_t.

explanatory power in the equations once all the other variables have been included in X_t.

The Expectational Hypotheses and Estimation Techniques

As noted in the Introduction, two expectational hypotheses have been used in the empirical work regarding the expectations of the aggregate price level. The first is that the expected future values of PA are a function of its past values. The coefficients of the past values of PA are assumed to lie on a linear polynomial that is constrained to be zero at lag length q. The equation that is estimated is

$$(2) \quad P_t = X_t\beta + \int_0^q \alpha_{[j]} PA_{t-1-[j]} dj + u_t \;, \quad t = 1,\dots,T$$

$$= X_t\beta + \sum_{j=0}^{[q]-1} \alpha_j PA_{t-1-j} + (q-[q])\alpha_{[q]} PA_{t-1-[q]} + u_t, \; t = 1,\dots,T,$$

$$(3) \quad \alpha_j = \gamma_0 + \gamma_1 j \;, \quad j = 0,1,\dots,[q],q \;,$$

$$(4) \quad \alpha_q = 0 \;,$$

where q is a real number greater than or equal to 1, and [q] is the integer part of q. Equations (3) and (4) imply that

$$(5) \quad \alpha_j = -\gamma_1(q - j) \;.$$

Given (4) and (5), equation (2) can be written as

$$(6) \quad P_t = X_t\beta - \gamma_1\{\sum_{j=0}^{[q]-1} (q-j)PA_{t-1-j} + (q-[q])^2 PA_{t-1-[q]}\} + u_t$$

$$= X_t\beta - \gamma_1 Q_t + u_t \;.$$

This specification extends the traditional PDL setup by allowing q to be real-valued rather than integer-valued. This extension plus the specification in (2) yields a regression function that is differentiable in q. Therefore, the model is simply a nonlinear regression model, and under standard assumptions the least squares estimate of q and various functions of q and the other parameters, such as the sum of the PDL coefficients, are consistent and asymptotically normal. If the errors are iid and normally distributed, the estimates are also asymptotically efficient.

Given q, equation (6) is linear in coefficients, and so one way to estimate (6) is to search over q by running least squares regressions to find the value of q that leads to the smallest overall sum of squared residuals. Alternatively, since (6) is differentiable in q, a gradient method can be used to compute the estimates. Given the parameter estimates, the covariance matrix of the estimates, including the estimate of q, is easy to compute. The formula is given in Andrews and Fair (1989).

In most PDL applications one is interested in the sum λ of the lag coefficients. In the present context λ is given by

$$(7) \quad \lambda = \int_0^q \alpha_{[j]} dj = -\gamma_1 \int_0^q (q-[j]) dj = -\gamma_1 \left(\sum_{j=0}^{[q]-1} (q-j) + (q-[q])^2 \right) .$$

The formula for the asymptotic variance of the estimate of λ, $-\hat{\gamma}_1 \left(\sum_{j=0}^{[\hat{q}]-1} (\hat{q}-j) + (\hat{q}-[\hat{q}])^2 \right)$, is given in Andrews and Fair (1989).

The second expectational hypothesis is that expectations are rational. The coefficients of the expected future values of PA are assumed to lie on a linear polynomial that is constrained to be zero at lead length r. To see how the equation is estimated, let the expectation error for PA^e_{t+j} be (all expectations are assumed to be formed at the beginning of period t)

$$(8)\quad \epsilon_{t+j} = PA_{t+j} - PA^{e}_{t+j} \quad , \quad j = 0,1,\ldots,[r] \quad .$$

The equation that is estimated is

$$(9)\quad P_t = X_t\beta + \int_0^r \alpha_{[j]} PA^{e}_{t+[j]} dj + u_t \quad , \quad t = 1,\ldots,T \ ,$$

$$= X_t\beta + \sum_{j=0}^{[r]-1} \alpha_j PA_{t+j} + (r-[r])\alpha_{[r]} PA_{t+[r]} + v_t \quad , \quad t = 1,\ldots,T \ ,$$

where

$$(10)\quad v_t = \int_0^r \alpha_{[j]} \epsilon_{t+[j]} dj + u_t \quad .$$

Given (3) and (4) with r replacing q, equation (9) becomes

$$(11)\quad P_t = X_t\beta - \gamma_1 \Big(\sum_{j=0}^{[r]-1} (r-j) PA_{t+j} + (r-[r])^2 PA_{t+[r]} \Big) + v_t$$

$$= X_t\beta - \gamma_1 R_t + v_t \quad .$$

Consider first 2SLS estimation of (11). Let Z_t be a vector of first stage regressors. A necessary condition for consistency is that Z_t and v_t be uncorrelated. This will be true if both u_t and the ϵ_{t+j} are mean zero and uncorrelated with Z_t. The assumption that u_t is mean zero and uncorrelated with Z_t is the usual 2SLS assumption. The assumption that the ϵ_{t+j} are mean zero and uncorrelated with Z_t is the rational expectations assumption. If expectations are formed rationally and if the variables in Z_t are used (perhaps along with others) in forming the expectations of the PA_{t+j}, then Z_t and the ϵ_{t+j} are uncorrelated. Therefore, given this assumption (and the other standard assumptions that are necessary for consistency), the 2SLS estimator of β, γ_1, and r is consistent.

A problem with the 2SLS estimator in this context is that it ignores the m-dependent property of v_t. Because of the ϵ_{t+j}, v_t will in general be m-dependent with m = [r]-1 if r is not an integer and m = [r]-2 if r is an integer. The 2SLS estimates are consistent, but the standard formula for their covariance matrix is incorrect and the estimates are not efficient within the class of limited information estimators. Hansen's (1982) method of moments estimator takes account of the m-dependent character of v_t. It requires that a matrix M be obtained, where M is a consistent estimate of $\lim T^{-1}E(Z'vv'Z)$, where $v' = (v_1, \ldots, v_T)$ and $Z' = (Z_1, \ldots, Z_T)$. The exact way in which Hansen's method is applied in this case is discussed in Andrews and Fair (1989), where the formula for the covariance of the parameter estimates, including the estimate of r, is also presented.

As mentioned above, the vector Z_t consists of all or at least a subset of the variables used by agents at the beginning of period t in forming their expectations for periods t and beyond. The expectations must be rational in order for the parameter estimates to be consistent (otherwise Z_t and the ϵ_{t+j} will not necessarily be uncorrelated), but Z_t need not include all the variables used by agents in forming their expectations. The variables used for Z_t for the empirical work in this paper are discussed in the next section.

Dynamic Specifications

It is of interest to see if the disaggregate data used in this study can discriminate among various dynamic specifications of the price equation. A key issue is whether the price equation should be specified in level form or in change form. Theory is not very precise on which specification is likely to be better, although in the monopolistic competition model the choice variable is really the price level, not the change in the price. At any rate, it is possible to test empirically which specification is better, which is done here. Assume for now that equation (6) is to be estimated and that in X_t there is only one cost (input price) variable, I_{t-1}, one demand pressure variable, D_{t-1}, and no seasonal dummy variables.[3] In <u>level form</u> the price equation is taken to be

$$(12) \quad P_t = \beta_0 + \beta_1 t + \beta_2 D_{t-1} + \beta_3 I_{t-1} + \beta_4 P_{t-1} - \gamma_1 Q_t + u_t \ .$$

In <u>change form</u> the equation is taken to be

$$(13) \quad P_t - P_{t-1} = \eta_0 + \eta_1 t + \eta_2 D_{t-1} + \eta_3 (I_{t-1} - I_{t-2}) + \eta_4 (P_{t-1} - P_{t-2}) - \gamma_1 (Q_t - Q_{t-1}) + u_t \ .$$

Including the time trend t in equation (13) is designed to see if there is a trend in the change in prices not captured by the other explanatory variables; the constant term η_0 picks up the trend in the level of prices not captured by the other variables. Note that D_{t-1}, not $D_{t-1} - D_{t-2}$, is in (13). This seems consistent with common practice. For example, in Phillips-curve type equations, the change in prices (or wages) is a function of the level of the unemployment rate, not of the change in the unemployment rate.

It is not possible to nest (12) within (13) or vice versa, but they can each be nested in a more general model. This model is

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[3] In the estimation of the equations the cost and demand pressure variables are entered with a lag of one month, and so a lag of one is used for I and D in the following discussion.

(14) $P_t = \delta_0 + \delta_1 t + \delta_2 D_t + \delta_3 I_{t-1} + \delta_4 I_{t-2} + \delta_5 P_{t-1} + \delta_6 P_{t-2} + \delta_7 Q_t + \delta_8 Q_{t-1} + u_t$.

The restrictions in (14) implied by the level specification in (12) are $\delta_4 = \delta_6 = \delta_8 = 0$. The restrictions in (14) implied by the change specification in (13) are $\delta_3 = -\delta_4$, $\delta_5 = -\delta_6$, and $\delta_7 = -\delta_8$. These restrictions can be tested. If both sets of restrictions are accepted,[4] then the test has not discriminated between the two specifications. If neither set is accepted, then neither specification is supported by the data. Otherwise, one specification will be selected over the other. In what follows equation (14) will be called the unrestricted form of the price equation.

When the first expectational hypothesis is used, the test of the restrictions is the standard F test. When the second (rational) expectational hypothesis is used, the test is a χ^2 test. The objective function that Hansen's method minimizes is $v'ZM^{-1}Z'v$, where v, Z, and M are defined above. Let S^* be the value of the objective function in the unrestricted case, and let S^{**} be the value in the restricted case. Then $(S^{**} - S^*)/T$ is asymptotically distributed as χ^2 with k degrees of freedom, where k is the number of restrictions. A general proof of this is in Andrews and Fair (1987). In performing this test the value of M must be the same for both estimates, and for the results in this paper M was computed using the residuals from the unrestricted equation.

Equations (12) and (13) are also tested against a more general dynamic specification than that in (14). The more general specification is equation (14) with P_{t-3}, P_{t-4}, and P_{t-5} added:

[4]By "accepted" is meant that the restrictions are not rejected at whatever confidence level is being used.

$$P_t = \delta_0 + \delta_1 t + \delta_2 D_{t-1} + \delta_3 I_{t-1} + \delta_4 I_{t-2} + \delta_5 P_{t-1} + \delta_6 P_{t-2} + \delta_7 Q_t + \delta_8 Q_{t-1} + \delta_9 P_{t-3} + \delta_{10} P_{t-4} + \delta_{11} P_{t-5} + u_t \quad . \tag{15}$$

The three further restrictions implied by equations (12) and (13) are then $\delta_9 = \delta_{10} = \delta_{11} = 0$. In other words, testing (12) and (13) against (15) is testing the implicit assumption in (12) and (13) that the further lagged values of the price do not belong in the equation. Equation (15) will be called the general form of the price equation.

The exact equations that were estimated for each product are presented in the next section after the data have been discussed.

III. The Data

Monthly price data for 40 products were collected from the data on the producer price indexes compiled by the Bureau of Labor Statistics. The products are listed in Table 1. They range from chewing gum to rubber hoses. Products were chosen that seemed likely to be fairly homogeneous across time and for which monthly data for a fairly long period of time were available. These data are the data for P_t. Although ideally one would like price data at the individual firm level, the data collected here are probably as close as one can come to this ideal using government data. In future work it would be interesting to see whether enough data at the individual firm level could be collected to perform the kinds of tests reported in this paper.

The aggregate price variable, PA_t, was taken to be the producer price index for all commodities.

TABLE 1
The Forty Products and Their Inputs

	Code number
1. Chewing gum	02550201
1) Raw cane sugar	02520101
2) Flavoring syrup (fountain)	02640103
3) Cor. shp. cont. for food & beverages	09150323
4) Foil, plain (under .006 inches)	10250111
2. Bottled beer	02610101
1) Malt and malt byproducts	02640101
2) Cor. shp. cont. for food & beverages	09150323
3) Glass containers	138
3. Cola, bottled, excluding diet cola	02620106
4. Ginger ale	02620505
5. Club soda	02620507
1) Raw cane sugar	02520101
2) Flavoring syrup (fountain)	02640103
3) Glass containers	138
4) Cor. shp. cont. for food & beverages	09150323
5) Kola syrup, for use by bottlers (3 only)	02640105
6. Sole leather	042101
7. Upper leather, including patent	042102
1) Cattle hides	0411
8. Baseball glove	15120141
1) Finished cattlehide and kipside leather	0421
9. Household detergents	06710402
1) Fats and oils, inedible	064
2) Paperboard	091503
10. Shaving soap and cream	06750201
11. Cologne and toilet water	06750305
12. Cleansing creams	06750601
1) Essential oils (10 and 11 only)	067901
2) Metal cans and can components (10 only)	1031
3) Glass containers (11 and 12 only)	138
4) Fats and oils, inedible (12 only)	064
13. Passenger car/motorcycle inner tubes	07120221
1) Natural rubber	071101
2) Synthetic rubber	071102
14. Offset uncoated book paper	09130122
15. Unwatermarked bond, no. 4 grade	09130131
16. Cotton fiber writing paper	09130141
17. Newsprint	09130291
1) Woodpulp	0911
2) Softwood sulfate, bleached and semibleached	09110211

TABLE 1 (continued)

18. Paperbaord	0914
1) Woodpulp	0911
19. Ice cream carton	09150327
20. Milk carton, 1/2 gallon	09150329
21. Paper cups, hot	09150333
22. File folders	09150645
23. Index cards	09150647
1) Woodpulp	0911
24. Insect wire screening	10880721
25. Barbed and twisted steel wire	10880951
26. Galvanized nails	10880213
1) Plain wire, carbon steel	10170511
27. Wrench, open-end	10420131
28. Wrench, box	10420132
29. Adjustable wrench, including pipe	10420133
30. Screwdrivers	10420141
31. Pliers	10420151
32. Hammers, light forged	10420161
1) Bars, c.f., alloy	0170831
33. Cap screws	10810231
1) Bars, c.f., alloy	0170831
34. Ball and roller bearings	114905
1) Bars, c.f., alloy	0170831
2) Closed die forging, carbon steel	10151351
35. Dry cell size d flashlight batteries	11790211
1) Carbon and graphite products	117903
2) Lead, pig, common	10220127
36. Cutlery, razors and razor blades	1267
1) Strip, c.v., stainless	10170755
37. Portland cement	13220131
1) Sand, construction	13210101
2) Gravel, for concrete	13210111
38. Black lead pencil	15950125
1) Carbon and graphite products	117903
2) Other wood products	084
39. Toothbrush	15970245
1) Plastic resins and materials	066
40. Rubber hose	071304
1) Natural rubber	071101
2) Synthetic rubber	071102

Table 1 also lists some of the main inputs for each product. Monthly price data on these inputs were also collected. The inputs for each product were chosen through examinations of input-output tables and from talking with various people in the government who are involved in the collection of the data and who are knowledgeable about specific industries. Some of the inputs in Table 1 pertain to more than one product.

The price data in Table 1 are classified by product rather than by industry. The other data that were collected are classified by industry, and Table 2 contains the matching of the industries to the products. The first item under each product is the relevant industry from the industrial production data compiled by the Federal Reserve. Monthly seasonally adjusted data on the production index for each of these industries were collected. Let Y_t denote the production index for a given industry. The data on Y_t were used to create a capacity utilization variable, CU_t. Peak-to-peak interpolations of Y_t were made, and capacity, C_t, was assumed to lie on the interpolation lines. Given C_t, CU_t is equal to Y_t/C_t. If capacity utilization is large (close to one), this may indicate that the demand curve facing the firm has shifted out, which may lead the firm to raise its price. The one-month lagged value of CU_t, CU_{t-1}, was taken to be one of the demand-pressure variables to be included in X_t.

The second item in Table 2 under each product is the relevant industry from the shipments and inventory data compiled by the Bureau of the Census. Monthly seasonally adjusted data on inventories and shipments were collected for each of these industries. Let V_t denote the stock of inventories at the end of month t, and let S_t denote the level of shipments in month t. If the ratio of inventories to shipments, V_t/S_t, is low, this may also indicate

TABLE 2

The Forty Products and Their Industry Matching

1. Chewing gum
    1) none
    2) All other foods 64
    3) Confectionery products 2065

2. Bottled beer
    1) Beer and ale 2082,3
    2) Beverages 62
    3) Malt beverages 2082

3. Cola, bottled, excluding diet cola
4. Ginger ale
5. Club soda
    1) Soft drinks 2086,7
    2) Beverages 62
    3) Bottled and canned soft drinks 2086

6. Sole leather
7. Upper leather, including patent
    1) Leather and products 31
    2) Leather, industrial products, and cut stock 94
    3) Leather and leather products 31

8. Baseball glove
    1) Personal leather goods 313,5-7,9
    2) Other leather products 95
    3) Leather and leather products 31

9. Household detergents
    1) Soap and toiletries 284
    2) Drugs, soaps, and toiletries 85
    3) Soap and other detergents 2841

10. Shaving soap and cream
11. Cologne and toilet water
12. Cleansing creams
    1) Soap and toiletries 284
    2) Drugs, soaps, and toiletries 85
    3) Toilet preparations 2844

13. Passenger car/motorcycle inner tubes
    1) Tires 301
    2) Tires and tubes 92
    3) Tires and inner tubes 301

TABLE 2 (continued)

14. Offset uncoated book paper
15. Unwatermarked bond, no. 4 grade
16. Cotton fiber writing paper
17. Newsprint
    1) Paper 262
    2) Pulp and paperboard mills, except biilding paper 74
    3) Paper and allied products 26

18. Paperboard
    1) Paperboard 263
    2) Paperboard containers 76
    3) Paperboard mills 263

19. Ice cream carton
20. Milk carton, 1/2 gallon
21. Paper cups, hot
    1) Paperboard containers 265
    2) Paperboard containers 76
    3) Paperboard containers and boxes 265

22. File folders
23. Index cards
    1) Converted paper products 264
    2) Paperboard containers 76
    3) Paperboard containers and boxes 265

24. Insect wire screening
25. Barbed and twisted steel wire
26. Galvanized nails
    1) Fabricated metal products 34
    2) Building materials and wire products 18
    3) Misc. fabricated wire products 3496

27. Wrench, open-end
28. Wrench, box
29. Adjustable wrench, including pipe
30. Screwdrivers
31. Pliers
32. Hammers, light forged
    1) Hardware, tools, anc cutlery 342
    2) Cutlery, hand tools, and hardware 17
    3) Hand and edge tools, and handsaws 3423,5

33. Cap screws
    1) Fasteners, stampings, etc. 345-7
    2) Other fabricated metal products 20
    3) Screw machine products 3451

34. Ball and roller bearings
    1) Special and general industrial equipment 355
    2) Miscellaneous equipment 26
    3) Ball and roller bearings 3562

TABLE 2 (continued)

35. Dry cell size d flashlight batteries
    1) Replacement storage batteries 3691
    2) Electronic components 38
    3) Storage batteries 3691

36. Cutlery, razors and razor blades
    1) Hardware, tools, and cutlery 342
    2) Cutlery, hand tools, and hardware 17
    3) Cutlery, hand tools, and hardware 342

37. Portland cement
    1) Cement 324
    2) Other stone, clay, and glass products 09
    3) Cement, hydraulic 324

38. Black lead pencil
    1) Miscellaneous business supplies 395,9
    2) Other durable goods 53
    3) Pens, pencils, office and art supplies 395

39. Toothbrush
    1) Plastics products, n.e.c. 307
    2) Other rubber and plastics products, n.e.c. 93
    3) Miscellaneous plastics products 307

40. Rubber hose
    1) Rubber products excluding tires 302-4,6
    2) Other rubber and plastics products, n.e.c. 93
    3) Reclaimed rubber, hose and belting 303,4

Notes:
1) Industrial production data from the Federal Reserve -- data for CU.
2) Shipments and inventories data from the Bureau of the Census -- data for S and V.
3) Employment, hours, and earnings data from the Bureau of Labor Statistics -- data for W, WT, H, and HO.

The numbers following 1) and 3) are SIC industry codes.

The numbers following 2) are product codes used by the Bureau of the Census.

that the demand curve facing the firm has shifted out, which may lead the firm to raise its price. V_{t-1}/S_{t-1} was also taken to be one of the demand-pressure variables to be included in X_t.

The third item in Table 2 under each product is the relevant industry from the employment, hours, and earnings data compiled by the Bureau of Labor Statistics. Monthly seasonally adjusted data on wage rates, hours, and overtime hours were collected for each of these industries. Let WT_t denote the average hourly wage, H_t the number of hours worked per week, and HO_t the number of overtime hours worked per week. WT_t is not adjusted for overtime hours, and so a new wage variable, W_t, was constructed, where $W_t = (WT_t H_t)/(H_t + .5HO_t)$. W_t is adjusted for overtime hours under the assumption that overtime hours are paid time and a half. For some industries not enough data on H_t and HO_t were available to construct W_t, and in these cases WT_t was used in place of W_t.

W_{t-1} (or WT_{t-1}) was included in X_t as one of the cost variables. In addition, the one-month lagged ratio of overtime hours to total hours, HO_{t-1}/H_{t-1}, was included in X_t (data permitting) as another demand-pressure variable. If overtime hours are high, this may indicate that the demand curve facing the firm has shifted out, which may lead the firm to raise its price.

Table 3 presents the equations that were estimated for each product and the sample periods that were used. The table is self explanatory, and it will only be briefly discussed here. The change form is equation (12); the level form is equation (13); the unrestricted form is equation (14); and the general form is equation (15). All the sample periods cover the turbulent period of the 1970's. Some are shorter than others because of data

TABLE 3

The Equations and Sample Periods

Each equation contains a constant term, a linear time trend, and 11 seasonal dummy variables. Let A_t denote the vector of these variables for month t. Let P_{it} denote the price of input i for a given product, where the inputs are listed in Table 2. i runs from 1 up to a maximum of 5. Let B_t denote the vector $(P_{1t},...,P_{nt})$, where n is the number of inputs for the given product (n may be 1). Let DB_t denote the vector $(P_{1t}-P_{1t-1},...,P_{nt}-P_{nt-1})$. The specifications are:

Change Form:

LHS variable: P_t

RHS variables: A_t, B_{t-1}, W_{t-1} or WT_{t-1}, CU_{t-1}, V_{t-1}/S_{t-1}, HO_{t-1}/H_{t-1}, P_{t-1}, and Q_t or R_t.

Level Form:

LHS variable: P_t-P_{t-1}

RHS variables: A_t, DB_{t-1}, $W_{t-1}-W_{t-2}$ or $WT_{t-1}-WT_{t-2}$, CU_{t-1}, V_{t-1}/S_{t-1}, HO_{t-1}/H_{t-1}, $P_{t-1}-P_{t-2}$, and Q_t-Q_{t-1} or R_t-R_{t-1}.

Unrestricted Form:

LHS variable: P_t

RHS variables: A_t, B_{t-1}, B_{t-2}, W_{t-1} or WT_{t-1}, W_{t-2} or WT_{t-2}, CU_{t-1}, V_{t-1}/S_{t-1}, HO_{t-1}/H_{t-1}, P_{t-1}, P_{t-2}, Q_t or R_t, and Q_{t-1} or R_{t-1}.

General Form:

LHS variable: P_t

RHS variables: A_t, B_{t-1}, B_{t-2}, W_{t-1} or WT_{t-1}, W_{t-2} or WT_{t-2}, CU_{t-1}, V_{t-1}/S_{t-1}, HO_{t-1}/H_{t-1}, P_{t-1}, P_{t-2}, Q_t or R_t, Q_{t-1} or R_{t-1}, P_{t-3}, P_{t-4}, and P_{t-5}.

Special Features:

Neither W nor WT appear in 24-31 and 35. W appears in 6-8, 13-23, 34, and 36-40. WT appears in 1-5, 9-12, and 32. HO/H appears only in 6-8, 13-23, 34, and 35-40. CU does not appear in 1.

TABLE 3 (continued)

Product	Sample Period	T	k_1	k_2	Product	Sample Period	T	k_1	k_2
1	1961.07-1985.12	294	21	28	21	1967.07-1985.06	216	20	24
2	1967.07-1987.12	246	21	27	22	1958.07-1988.05	359	20	24
3	1969.07-1985.12	198	23	31	23	1958.07-1980.07	265	20	24
4	1961.07-1985.07	289	22	29	24	1958.07-1988.05	359	18	21
5	1961.07-1985.12	294	22	29	25	1958.07-1988.05	359	18	21
6	1958.07-1983.08	302	20	24	26	1958.07-1984.07	313	18	21
7	1958.07-1988.05	359	20	24	27	1958.07-1985.10	328	18	21
8	1958.07-1985.02	320	20	24	28	1958.07-1988.05	359	18	21
9	1958.07-1988.05	359	20	25	29	1958.07-1988.05	359	18	21
10	1958.07-1986.12	342	20	25	30	1958.07-1988.05	359	18	21
11	1958.07-1988.05	359	20	25	31	1958.07-1988.05	359	18	21
12	1958.07-1988.05	359	20	25	32	1967.07-1988.05	251	19	23
13	1958.07-1985.12	330	21	26	33	1964.07-1988.05	287	18	21
14	1958.07-1988.05	359	21	26	34	1961.07-1988.05	323	21	26
15	1958.07-1988.05	359	21	26	35	1961.07-1988.05	323	19	23
16	1958.07-1987.12	354	21	26	36	1958.07-1988.05	359	20	24
17	1958.07-1988.05	359	21	26	37	1958.07-1988.05	359	21	25
18	1958.07-1988.05	359	20	24	38	1967.07-1985.12	222	21	26
19	1964.06-1985.06	253	20	24	39	1958.07-1981.12	282	20	24
20	1964.06-1985.06	253	20	24	40	1972.07-1985.12	162	21	26

Notes:

T is the total number of observations.

k_1 is the number of explanatory variables in the change form and in the level form.

k_2 is the number of explanatory variables in the unrestricted form.

The number of explanatory variables in the general form is $k_2 + 3$.

Notation:

- A : See above.
- B : See above (the P_i variables are in logs).
- CU : Capacity utilization.
- DB : See above (the P_i variables are in logs).
- H : Total hours per worker.
- HO : Overtime hours per worker.
- P : Price of the product (in logs).
- Q : Aggregate price expectations variable for the first expectational hypothesis (in logs).
- R : Aggregate price expectations variable for the second expectational hypothesis (in logs).
- S : Sales.
- V : Stock of inventories.
- W : Wage rate adjusted for overtime hours (in logs).
- WT : Wage rate not adjusted for overtime hours (in logs).

limitations. The number of observations ranges from 162 to 359. More than half of the sample periods have over 300 observations. The number of explanatory variables in the level and change forms varies from 18 to 23, counting the aggregate price expectations variable as one.[5] The number of explanatory variables in the unrestricted form varies from 21 to 31. The general form includes three more variables, namely the three lagged values of the price.

When the unrestricted and general forms were estimated, the same value of q was assumed for both Q_t and Q_{t-1} and the same value of r was assumed for both R_t and R_{t-1}. This treatment is consistent with the view that Q_{t-1} is simply Q_t lagged one month and that R_{t-1} is simply R_t lagged one month.

The variables used for Z_t under the second (rational) expectations hypothesis are the following. First, all the explanatory variables in the general form of the equation for the given product were used except for R_t and R_{t-1} (for all the forms estimated). Second, PA_{t-1}, PA_{t-2}, PA_{t-3}, PA_{t-4}, and PA_{t-5} were used. Finally, the one-month and two-month lagged values of the unemployment rate, the overall industrial production index, the three-month Treasury bill rate, and the 10-year government bond rate were used. These are the variables that agents are assumed to use (perhaps along with others) in forming their expectations.

It should be noted that q and r cannot be less than one. In a number of cases the optimum occurred at a value of q or r of one, and these are the estimates reported below. Also, a maximum of q of 132 (11 years) was set, and in a few cases the optimum occurred at a value of q of 132. Similarly,

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[5]The number of parameters estimated is one greater than the number of explanatory variables listed because the lag length q or the lead length r is estimated along with the other parameters.

a maximum of r was set at 12, and in a few cases the optimum occurred at this value.

IV. The Results

Tables 4 and 5 present a summary of the all the results, and this section is a discussion of these two tables. Table 4 summarizes the results for the first expectational hypothesis, and Table 5 summarizes the results for the second. A fairly systematic procedure was followed in the estimation work. Consider first the results in Table 4. Four equations were estimated per product[6] -- the level, change, unrestricted, and general forms -- and from these estimates four F values were computed. The first F value tests the restrictions in the level form relative to the restricted form; the second tests the restrictions in the level form relative to the general form; the third tests the restrictions in change form relative to the unrestricted form; and the fourth tests the restrictions in the change form relative to the general form.[7]

If the restrictions implied by the level form are rejected at the 1 percent level in both cases, i.e., compared to both the unrestricted and general forms, the estimates of λ, the sum of the PDL coefficients, and q are not recorded in Table 4. When these two rejections take place, it is a clear rejection of the level form of the price equation, and so further examination of the equation is not of interest. Similarly, if the

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[6]The estimates were obtained by searching over values of q. The final grid search was .01. The estimates in Table 5 were obtained by searching over values of r. The final grid search in this case was .1.

[7]The degrees of freedom for the F test (and for the χ^2 test in Table 5) can be calculated from the numbers presented in the last half of Table 3.

TABLE 4

Results Using the First Expectational Hypothesis

	Level Form						Change Form						General Form	
Product	F_1	$\hat{\lambda}$	t_λ	$\hat{q}$	SE_q	F_2	F_3	$\hat{\lambda}$	t_λ	$\hat{q}$	SE_q	F_4	F_5	$\hat{q}$
1	6.28**					4.82**	1.92	1.141	2.24	38.24	23.89	1.76	0.33	
2	1.00	.036	1.22	5.44	12.07	1.70	1.62	.400	2.58	27.28	15.56	2.13*	0.78	
3	2.91**					3.55**	2.61**					3.31**	3.14*	13.45
4	0.51	-.035	-1.68			0.80	1.70	.891	3.12	30.38	14.33	1.64	0.39	
5	3.06**					2.75**	2.47*	.824	1.80	31.10	26.76	2.33*	1.26	
6	4.54**					3.11**	10.88**					6.79**	3.74*	10.08
7	14.21**					8.69**	4.09**					2.89**	0.34	
8	3.47**					3.49**	4.36**					4.01**	3.81*	13.18
9	1.05	.071	3.43	1.00	-	0.89	3.44**	.525	3.78	9.34	2.96	2.39*	3.50*	9.10
10	2.47*	.408	6.43	115.38	15.69	2.91**	14.68**					10.73**	1.85	
11	3.64**					7.48**	9.70**					11.69**	4.13**	9.00
12	2.38*	.080	2.50	3.37	10.18	2.41*	3.17**					2.91**	2.51	
13	1.58	.065	1.67	1.00	-	1.01	2.26	1.677	4.02	18.51	6.93	1.43	1.63	
14	3.32**					6.49**	4.95**					7.61**	7.79**	22.38
15	3.36**					2.96**	1.34	.401	2.66	14.17	7.10	1.68	2.89*	14.18
16	8.26**					6.49**	2.92*	.314	1.71	46.00	38.61	3.08**	2.62	
17	2.58*	.016	0.40			3.08	5.01**					4.64**	0.66	
18	9.37**					6.41**	2.28	.751	4.33	18.63	6.38	2.30*	1.02	
19	0.43	.124	3.63	1.00	-	0.64	3.66**	.859	4.13	8.17	1.87	2.48*	4.05**	8.14
20	3.86**	.244	4.42	132.00	42.07	3.09	6.09**					4.39**	5.38**	132.00
21	0.58	.138	1.72	14.33	9.25	1.05	2.03	.770	1.75	26.16	19.54	1.88	0.66	
22	8.46**					5.39**	2.41	.649	3.43	8.49	2.71	1.92	1.12	
23	8.29**					4.75**	3.23**	.407	1.40	5.13	2.23	1.89	0.25	
24	17.69**					9.42**	1.74	1.016	6.31	6.05	1.02	1.43	13.11**	6.00
25	10.39**					10.78**	2.65	1.119	5.04	17.18	5.72	6.59**	8.59**	18.11
26	0.98	.097	4.35	5.38	6.09	1.41	13.07**					7.50**	7.82**	8.00
27	2.68*	.099	3.96	17.50	7.98	1.43	13.38**					6.73**	6.32**	90.10
28	2.66**	.072	4.03	1.00	-	1.69	3.59*	.861	4.75	20.40	6.99	2.15*	6.97**	21.31
29	0.75	.071	4.24	5.55	5.89	2.31*	4.62**					4.30**	8.22**	13.46
30	4.52**	.126	4.09	27.34	6.46	2.63*	12.52**					6.63**	8.18**	132.00
31	3.58*	.052	3.15	1.00	-	3.15**	5.45**					4.10**	7.86**	30.55
32	7.28**					4.28**	3.60**	.507	1.69	7.57	4.74	2.20*	4.04**	22.28
33	17.45**					15.36**	2.81*	.972	3.93	15.47	5.93	7.19**	6.96**	17.83
34	3.71**					2.75**	2.76*	.800	5.31	23.26	7.19	2.16*	3.94**	12.00
35	8.40**					5.05**	3.76**	-.240	-1.12			2.41*	1.00	
36	0.32	.078	2.88	22.38	9.16	0.77	2.85*	.755	3.13	61.11	23.75	2.22*	3.45**	25.27
37	1.55	.118	4.13	12.56	5.72	2.09*	4.84**					4.00**	6.91**	10.10
38	2.02*	.097	2.51	6.27	9.94	1.31	4.98**					3.14**	2.95*	4.25
39	2.53*	.011	0.37			1.85	4.24**					2.82**	0.38	
40	1.62	.043	1.06	1.00	-	1.71	5.19**					3.98**	0.49	

TABLE 4 (continued)

Notes:

*	significant at the 5 percent level.
**	significant at the 1 percent level.
F_1	F-statistic for the hypothesis that the restrictions in the level form relative to the unrestricted form are valid.
F_2	F-statistic for the hypothesis that the restrictions in the level form relative to the general form are valid.
F_3	F-statistic for the hypothesis that the restrictions in the change form relative to the unrestricted form are valid.
F_4	F-statistic for the hypothesis that the restrictions in the change form relative to the general form are valid.
F_5	F-statistic for the hypothesis that the coefficients of the price expectations variables (Q_t and Q_{t-1}) in the general form are zero.
$\hat{\lambda}$	Estimate of λ, the sum of the PDL coefficients.
t_λ	t-statistic for $\hat{\lambda}$.
$\hat{q}$	Estimate of q.
SE_q	Estimated standard error for $\hat{q}$.

TABLE 5

Results Using the Second Expectations Hypothesis

Prod-	Level Form						Change Form						General Form	
uct	x_1^2	$\hat{\lambda}$	t_λ	$\hat{r}$	SE_r	x_2^2	x_3^2	$\hat{\lambda}$	t_λ	$\hat{r}$	SE_r	x_4^2	x_5^2	$\hat{r}$
1	51.92**					59.11**	18.41*	.569	1.48	2.9	2.09	12.90**	3.02	
2	4.50	.025	1.05	12.0	42.95	7.67	13.84	.391	2.19	8.9	8.01	20.16*	1.00	
3	21.56**					23.89**	34.11**					38.26**	1.82	
4	10.34	.019	0.60			18.09*	14.74	.564	3.09	1.0	-	22.36*	1.37	
5	21.51**	.049	0.89			13.41	29.57*	.950	2.88	1.0	-	20.44*	4.48	
6	20.38**					39.74**	24.01**					44.21**	9.58*	4.9
7	61.27**					14.31**	67.62**					20.04**	0.92	
8	9.80*	.051	1.83	1.9	11.53	15.15**	20.66**					30.04**	6.30	
9	5.24	.064	3.40	8.3	14.91	25.04**	8.02	.530	4.59	8.9	6.46	28.84**	15.05**	12.0
10	9.69	.099	1.97	1.9	7.62	21.32**	53.52**					70.28**	11.16*	3.0
11	50.57**					33.68**	121.45**					78.85**	12.71**	1.8
12	10.78	.075	2.94	5.9	17.18	31.27	20.08*	.910	3.20	4.9	6.69	35.88**	11.34**	4.3
13	9.22	.071	1.80	12.0	51.31	15.47**	9.29	1.700	4.16	1.6	0.52	15.23	7.10	
14	11.56*	.127	3.55	5.1	10.84	12.20*	41.24**					42.86**	19.67**	4.1
15	15.57**	.075	3.05	6.2	9.70	13.03*	22.45**	.236	1.40	5.9	9.76	18.80*	7.37	
16	40.17**	.050	2.87	7.9	10.90	14.87*	56.29**					28.16**	8.44*	2.9
17	17.91**					36.60**	25.91**					47.57**	1.35	
18	39.26**	.043	2.51	12.0	31.68	5.09	37.00**	.952	4.97	2.2	1.54	10.71	3.98	
19	2.60	.115	3.64	1.7	2.65	21.28**	10.90	.668	4.39	2.9	0.70	28.91**	19.85**	1.9
20	23.06**					15.28**	33.77**					26.00**	11.33*	1.2
21	1.28	.104	2.02	7.9	10.35	6.88	10.07	.824	3.66	6.9	5.78	13.70	6.12	
22	37.39**					15.19**	41.62**					18.83**	5.29	
23	33.89**					14.68**	38.89**					19.97**	1.07	
24	18.87**	.096	4.23	12.0	9.69	10.87*	21.07**	.948	3.88	3.9	1.81	12.94*	18.44**	2.4
25	32.24**	.039	1.53	12.0	34.21	8.16*	66.57**					35.62**	24.23**	1.7
26	4.44	.086	4.28	1.9	3.15	32.13**	9.22	.935	3.81	5.9	3.77	44.70**	24.46**	2.9
27	6.20	.073	3.48	1.9	4.63	34.26**	9.62	.947	3.81	5.9	3.80	33.93**	15.52**	3.1
28	3.07	.075	3.58	9.0	21.82	14.52**	5.65	.875	3.72	6.9	4.93	18.01**	17.78**	1.9
29	1.75	.062	4.76	12.0	16.70	13.71**	15.22*	.780	5.27	6.9	4.28	23.92**	22.50**	3.0
30	6.78	.059	2.84	1.9	5.62	26.86**	12.69*	.697	3.58	1.4	0.82	33.48**	14.53**	7.1
31	4.14	.062	3.39	12.0	16.02	20.20**	7.47	.863	3.75	4.9	3.31	24.38**	14.66**	1.0
32	25.47**					17.73**	26.63**					18.96**	13.08**	1.9
33	57.92**	.085	3.44	12.0	12.28	8.75*	104.21**					37.62**	17.17**	3.9
34	19.56**					29.80**	23.30**					29.86**	19.53**	4.9
35	40.89**					14.58**	42.49**	-.298	-1.37			17.28*	3.19	
36	2.06	.038	2.12	4.9	13.86	13.89**	6.73	.507	3.03	1.0	-	17.54**	8.77**	4.9
37	5.10	.074	4.27	2.9	5.12	33.95**	14.18*	.895	4.03	2.2	2.22	39.51**	27.34**	1.4
38	10.55	.090	2.98	5.9	13.23	26.89**	11.01	.333	1.64	6.9	9.58	27.68**	11.44**	4.9
39	7.48	.007	0.37			19.34**	13.01	.200	1.10	3.6	8.22	24.96**	2.36	
40	9.20	.055	1.09	9.0	22.22	34.84**	16.85*	.609	3.52	1.7	0.44	41.77**	4.44	

TABLE 5 (continued)

Notes:

*	significant at the 5 percent level.
**	significant at the 1 percent level.
χ_1^2	χ^2-statistic for the hypothesis that the restrictions in the level form relative to the unrestricted form are valid.
χ_2^2	χ^2-statistic for the hypothesis that the restrictions in the level form relative to the general form are valid.
χ_3^2	χ^2-statistic for the hypothesis that the restrictions in the change form relative to the unrestricted form are valid.
χ_4^2	χ^2-statistic for the hypothesis that the restrictions in the change form relative to the general form are valid.
χ_5^2	χ^2-statistic for the hypothesis that the coefficients of the price expectations variables (Q_t and Q_{t-1}) in the general form are zero.
$\hat{\lambda}$	Estimate of λ, the sum of the PDL coefficients.
t_λ	t-statistic for $\hat{\lambda}$.
$\hat{r}$	Estimate of r.
SE_r	Estimated standard error for $\hat{r}$.

restrictions implied by the change form are rejected at the 1 percent level in both cases, the estimates of λ and q are not recorded. Note that this procedure gives the benefit of the doubt to the level and change forms regarding what is recorded in the tables. The estimates are not presented only if the restrictions are rejected at the 1 percent level for both tests. For purposes of reporting the results it seemed better to err on the side of presenting too many estimates than too few.

When the estimates are recorded for a given product, the estimate of λ and its t-statistic are presented. The t-statistic tests whether the sum of the coefficients of the past values of the aggregate price variable is significantly different from zero. If the t-statistic is quite low, which is taken here to be less than one, then the aggregate price variable is clearly not significant. In this case it is of no interest to examine the estimate of q, and so when a t-statistic is less than one in Table 4, the estimate of q is not presented. Similarly, if the estimate of λ is negative, which is not sensible, the estimate of q is not presented. When the estimate of q is presented in the table, its estimated standard error is also presented unless the estimate of q is one, which is a corner solution.

A fifth F-statistic is also presented in Table 4. This statistic tests whether Q_t and Q_{t-1} are jointly significant in the general form of the equation. Computing this statistic requires that a fifth regression be run for each product, namely the general form without Q_t and Q_{t-1} included. This F test is particularly useful when both the level and change forms have been rejected. It tests for the significance of the aggregate price expectations variable in an equation that is less likely to be dynamically misspecified. This test has three degrees of freedom in the numerator, one each for Q_t and Q_{t-1} and one for q. When Q_t and Q_{t-1} are jointly significant at the 5 percent level, the estimate of q is also presented in Table 4. This is the estimate of q under the most general dynamic specification.

It will be useful to discuss the results in Table 4 before considering Table 5. Consider the level versus change forms first. Both the level and change forms are rejected in 19 of the 40 cases. For 6 products both forms are rejected, and for 8 products both are accepted. It thus seems at first glance that both forms do about the same. However, for all 8 of the products for which both are accepted, the level form has a better fit (and thus a lower F-statistic) than does the change form. If one counts these cases as a rejection for the change form, the change form is then rejected in 27 of the 40 cases compared to only 19 for the level form. There is thus at least a slight edge in favor of the level form, although only slight.

The estimate of λ is significant[8] in 14 of the 21 cases in which the level form is accepted, and it is significant in 15 of the 21 cases in which the change form is accepted. For the general form the aggregate price expectations variable is significant at the 5 percent level or greater in 23 of the 40 cases. This is thus fairly strong evidence in favor of the hypothesis that aggregate price expectations matter. In over half the cases the price expectations variable is significant.

The estimates of q vary considerably across the products, and in general they have large standard errors. The data clearly seem better at tacking down the sum of the PDL coefficients (λ) than they do at choosing

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[8] The estimate of λ will be said to be significant if its t-statistic is greater than two in Table 4.

the lag length. It can be seen in the last column in Table 4, however, that the estimates of q in the most general specification are not too variable. Omitting the three largest values (132.00, 132.00, and 90.10), the range is 4.25 to 30.55. Agents are thus estimated to look back between about 4 months and 31 months in forming their expectations of the future.

The results for Table 5 were obtained in a similar manner as they were for Table 4, where χ^2 tests are used in place of F tests. The only difference is that six equations had to be estimated rather than four. For example, the level form had to be estimated twice, once using the estimate of M computed from the residuals from the unrestricted form and once using the estimate of M from the residuals from the general form. Likewise, the change form had to be estimated twice. Also, for the fifth χ^2 test the general form of the equation without R_t and R_{t-1} included had to be estimated by Hansen's method using the same M matrix that was used to estimate the general form with the two variables included.

The results in Table 5 are qualitatively similar to those in Table 4. The level form is rejected in 12 of the 40 cases, and the change form is rejected in 16 of the 40 cases. These compare to 19 each in Table 4. For 10 products both forms are rejected, compared to 6 in Table 4, and for 22 products both are accepted, compared to only 8 in Table 4. There is thus less discrimination between the two forms in Table 5 than in Table 4, although the level form still has a slight edge.

The estimate of λ is significant in 19 of the 28 cases in which the level form is accepted, and it is significant in 19 of the 24 cases in which the change form is accepted. For the general form the aggregate price expectations variable is significant at the 5 percent level or greater in 23 of the 40 cases. Again, as in Table 4, this is fairly strong evidence in favor of the hypothesis that aggregate price expectations matter.

The estimates of r in Table 5 range from 1.0 to 12.0, the minimum and maximum allowed. Of the 71 estimates of r presented, counting the estimates for the general form, four are 1.0 and nine are 12.0. If for the general form the two largest estimates of r are excluded (12.0 and 7.1), the estimates range from 1.0 to 4.9. In most cases the horizon thus seems to be less than six months regarding the effect of future expectations on current decisions.

V. Conclusion

The results in Tables 4 and 5 strongly support the hypothesis that aggregate price expectations affect individual pricing decisions. Even under the most general dynamic specification, the expectations variables are significant in over half of the cases. The results do not discriminate very well between the level and change forms of the price equation. There is a slight edge for the level form, but only slight. The lag length for the first expectational hypothesis is not estimated precisely, although in most cases it is less than 30 months. The lead length for the second (rational) expectational hypothesis is less than 5 months in most cases, although it too is not estimated precisely.

As noted in Section III, it would be interesting in future work to see if tests similar to those performed in this paper could be performed using individual firm data. The better the data, the less likely is it that the price equation has omitted variables that are correlated with the aggregate price expectations variable, thus biasing the results in favor of the expectations hypothesis.

In future work with individual firm data it might also be of interest to test the first (naive) expectational hypothesis against the second (rational) one. No attempt was made to test the two hypotheses in this paper. Collinearity problems are likely to be severe in carrying out this test, and the main conclusions of this paper are not sensitive to the particular hypothesis used.[9]

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[9]The rational expectations hypothesis is tested in Fair (1989) using aggregate data, and the results provide only mild support for it.

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