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Expectations, Tobin's q, and Investment: A Note

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IN A RECENT ISSUE of this journal, Malkiel, von Furstenberg, and Watson [5] (hereafter referred to as MFW) made an important contribution to the theory of investment. Their model focused special attention on the formation of expectations and the presence of lags between investment decisions and the ultimate completion of investment projects. Using industry data, they were able to estimate investment equations which approximated the relationships which they had derived theoretically. Their results indicated that both changes in output relative to trend and changes in Tobin's q ratio (the market value of the firm divided by the replacement costs of its assets) affected investment decisions. In this note we use the MFW model with more dissaggregated data to investigate further the determinants of changes in investment.

The specification of the empirical model which we use is provided by Equation (23) in MFW:

$$\Delta I_t/K_t^m = b_o + b_1'\Delta(Q/Q^m)_{t-1} + b_2'\Delta(q_{t-1}/\bar{q}) \tag{23}$$

where:

I = Gross investment;

K^m = Trend value of the net capital stock;

Q = Output;

Q^m = Trend value of output;

q = Tobin's q ratio; and

$\bar{q}$ = Long run average value of q

Equation (23) illustrates the important features of the MFW model. From the "demand" side, expected future output will affect desired capital stocks, hence investment. Thus, the change in the ratio of output to its trend value is included as a determinant of changes in investment. When $\Delta(Q/Q^m)_{t-1}$ is positive, MFW hypothesize that firms anticipate a need for larger future capital stocks. From the "supply" side, expectations about future profitability influence desired capital-output ratios. Tobin's q reflects the market's valuation of the firm's future profit prospects, and therefore guides investment decisions. When q is higher than its long-run equilibrium value ($\bar{q}$), investment is encouraged; when q is lower than

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$\bar{q}$, investment is depressed.[1] Positive signs were therefore anticipated for both b_1' and b_2'.

MFW estimated separate equations for a variety of 2-digit SIC manufacturing industries using annual data for the 1956–76 period. Results of the analysis confirmed their hypotheses. In 16 estimated equations, the estimate for b_1' was positive 15 times and that for b_2' was always positive. The b_2' estimate was usually significant; however, that for b_1' was not. MFW (p. 556) also noted that "... while b_1' and b_2' are of a similar order of magnitude, the standard deviation of $\Delta(q_{t-1}/\bar{q})$ is generally much larger than that of $\Delta(Q/Q^m)_{t-1}$." The results therefore indicated that changes in q had a considerably greater impact on investment than changes in Q. MFW noted that the relative importance of these effects was the inverse of that found by von Furstenberg [5] in a study of aggregate investment for the nonfinancial corporate sector, and they suggested that there might be "... a general tendency for q to come through more strongly the lower the level of aggregation" (p. 559).

In this note, we report results of estimating the MFW model using individual firm data. Although both the MFW model and the q theory of investment, originally espoused by Brainard and Tobin [1], rely on models of individual firm decisionmaking, there has been little related empirical work at the firm level. Our results also provide additional evidence on relative importance of Q and q in explaining investment, and allow us to test the conjecture of MFW that the effects of q show up more strongly at lower levels of aggregation. Our sample of firms consists of all (287) manufacturing firms from the 1976 Standard and Poor 400 for which sufficient data were available to permit computation of the q series.[2] All data were obtained from the Standard and Poor Compustat tape.

To compute q ratios, we rely primarily on the methodology of Lindenberg and Ross [6], who have described their computational procedures in detail.[3] The firm's q ratio, it is recalled, is the ratio of the firm's market value (of common stock, preferred stock, and debt) to the replacement cost of its assets (plant and equipment, inventory, and other assets). We must therefore calculate values for each of these components of the q ratio.

Market value of common stock at year-end prices is readily available; however, Compustat provides only book values of preferred stock. To approximate the market value of preferred stock, preferred dividends for the year were divided by Standard and Poor's preferred stock yield index. To calculate the market value of debt, given only book values, we assumed that all bonds have a 20-year maturity, and offer a yield equal to the corporate average (at the time of issuance) for new issues of its rating. Using the method of Lindenberg-Ross, we approximated the fractions of total debt which were issued in each of the preceding 20 years. The present value of debt issued in each of those years was then calculated

[1] See Brainard and Tobin [1], Ciccola and Fromm [3], Smith [8], Richards [7], and Yoshikawa [9] on the relationship between the q ratio and investment.

[2] Of the Standard and Poor 400, only 315 companies were manufacturing firms, and 28 of these lacked data necessary to compute a complete time series for q.

[3] We have deviated from the Lindenberg-Ross approach by assuming a five percent depreciation rate for the capital stock, as Tobin and Brainard did in their original paper, rather than using depreciation rates calculated from accounting data and adjusted to reflect technical obsolescence.

straightforwardly, given knowledge of the yield of those bonds and the current yield on bonds of identical rating. For the denominator of q, we calculated the replacement cost of capital assets. To do so, we assumed that in 1963, our "base" year, the replacement cost of plant and equipment was equal to the book value of net plant and equipment. For succeeding years, we adjusted replacement cost to account for new investment (the reported increase in gross plant), depreciation (a 5% depreciation rate was assumed), and inflation (as measured by the price deflator for the fixed investment component of GNP). We have again followed the procedures of Lindenberg and Ross in adjusting book value of inventory to reflect replacement costs. Adjustments were made to correct for the tendency of some inventory valuation procedures to understate replacement costs in inflationary times, and the specific adjustments made depend upon the inventory valuation method chosen by individual firms. The "other" assets category includes liquid assets, land, and intangibles. By necessity, we assumed that replacement costs equal book values for assets in this category. Tobin's q was then calculated as the ratio of total market value (of common stock, preferred stock, and debt) to replacement costs (of plant and equipment, inventories, and other assets). For firms in the sample, q ratios were computed for each year from 1963 to 1976, and $\bar{q}$ was computed as the mean of the individual year q ratios.

Other data series were readily available from Compustat. For the capital stock series, we use the replacement cost of plant and equipment which was previously calculated in the construction of q ratios, and the investment series was obtained by computing yearly differences in the level of gross plant reported by Compustat.[4] Our output measure is simply the total sales of the firm, and trend values for output and the capital stock are the predicted values obtained from a regression of actual values on a constant term and a time trend.

We have estimated 287 time series regressions, one for each firm, using the specification provided by Equation (23). The equations are estimated for the 1965–76 time period. Results of these regressions are summarized in Table I, and complete results are available upon request from the authors. In the 287 estimated equations, b_1' has a positive sign 197 times, while b_2' has a positive sign 188 times. In addition, b_1' is significantly positive at the .05 level for a one-tailed test 42 times, while b_2' is significantly positive 41 times.[5] Our results do not exhibit the regularity of those MFW, but this is to be expected given the lower level of aggregation and the smaller number of observations. One would not expect that each firm would act as the theory hypothesizes. Nevertheless, the evidence does strongly support the hypotheses of MFW. If b_1' and b_2' were actually equal to zero for all companies, one would expect to obtain roughly equal numbers of positive and negative estimated coefficients. Instead, we have found that about 2/3 of the estimates for each coefficient are positive.[6]

In contrast to the findings of MFW, our results do not suggest that $\Delta(q_{t-1}/\bar{q})$

[4] Inventory investment was excluded since it may vary unexpectedly with demand fluctuations. Our concern is with planned investment.

[5] The critical value for t at the .05 level for a one-tailed test with 9 degrees of freedom is 1.833.

[6] If b_1' and b_2' were actually equal to 0 for all companies, one would typically expect only about 14 (5%) of all estimates to appear to be "significantly positive." Instead, the number of significant coefficients was three times that number.

Table I

Determinants of the Change in Firms' Investment: A Summary

	$\Delta(Q/Q^m)_{t-1}$	$\Delta(q_{t-1}/\bar{q})$
	b_1'	b_2'
Complete Sample (287 Firms)		
Mean b_i'	.201	.064
Maximum b_i'	3.792	2.003
Minimum b_i'	−1.326	−1.512
Mean "standardized"[a] b_i'	.162	.124
Number of b_i'	197	188
Number of $b_i' > 0$ significant at .10 level[b]	57	61
Number of $b_i' > 0$ significant at .05 level[c]	42	41
50 Largest Firms		
Mean b_i'	.164	.071
Maximum b_i'	2.903	.995
Minimum b_i'	−.753	−.513
Mean "standardized"[a] b_i'	.1151	.1309
Number of $b_i' > 0$	33	33
Number of $b_i' > 0$ sigificant at .10 level[b]	7	7
Number of b_i' significant at .05 level[c]	4	6

[a] The "standardized" coefficients are equal to the coefficient estimate multiplied by the standard deviation of the corresponding regressor.

[b] The critical value for t for a one-tailed test with significance level .05 is 1.833.

[c] The critical value for t for a one-tailed test with significance level .10 is 1.383.

has greater explanatory power than $\Delta(Q/Q_m)_{t-1}$. The coefficient of $\Delta(Q/Q_m)_{t-1}$ has a higher mean and is positive more often. Even when the independent variables were standardized by dividing by their respective standard deviations, the mean of the resulting "beta coefficients" was slightly higher for $\Delta(Q/Q_m)_{t-1}$ than for $\Delta(q_{t-1}/\bar{q})$. Although these results do not strongly refute the evidence of MFW on the relative effects of the two explanatory variables, they do cast doubt on the conjecture that there is a tendency for q to show greater strength at lower levels of aggregation.

We have investigated several possible explanations for this difference between our findings and those of MFW. First, if large firms tend to behave more in accordance with the results of MFW than do small firms, then the difference in findings could be attributed to the greater weight given large firms when one aggregates to the industry level. Results in Table I do show some evidence of differences in behavior between large and small firms. For the sample of the 50 largest firms b_1' and b_2' have equal numbers of positive signs and comparable significance levels. The standardized beta coefficients were also comparable in size, although $\Delta(q_{t-1}/\bar{q})$ now has the larger mean beta coefficient. There is a slight tendency for large firms to behave more in accordance with the findings of MFW; however, these differences are not large enough to completely account for the divergence between our results and those of MFW.

We have also grouped firms according to their 2-digit industrial classification to compare results with those of MFW. For all industry groupings, we found that both explanatory variables generally had the expected positive effect; however, the relative explanatory power of the two variables differed across industries. Although MFW found that $\Delta(q_{t-1}/\bar{q})$ usually had greater impact, their results indicate that for 4 of the 11 manufacturing industries they studied (chemicals and products, petroleum and related products, primary metals, and nonelectrical machinery), the effects of $\Delta(Q/Q_m)_{t-1}$ were apparently as large or larger. Our results for these industries are similar. Interestingly, although firms in our sample come from 20 2-digit industries, 117 of the firms (40.8%) come from the 4 industries noted above. Thus, our sample is clearly weighted toward those industries for which $\Delta(Q/Q_m)_{t-1}$ has stronger impact, and this accounts for some of the difference between our results and those of MFW. For several other industries (electrical machinery; paper products; clay, glass, and stone products; and transportation equipment) our results differ from those of MFW, however. We find a larger impact for $\Delta(Q/Q_m)_{t-1}$, whereas they found $\Delta(q_{t-1}/\bar{q})$ had greater impact.[7] For the remaining industries studied by MFW (rubber and plastics products, foods, and textile mill products) our results are consistent with theirs in showing greater importance for $\Delta(q_{t-1}/\bar{q})$.

Our analysis has shown that estimating the MFW model using individual firm data yields results which are qualitatively similar to those reported previously using more aggregated data. Our results differ from those of MFW regarding the relative importance of q and Q in explaining investment. Evidence suggests that behavioral differences between industries, combined with the particular distribution of firms across industries in our sample, can partially explain the differing results. Differences in behavior between large and small firms may also be partially responsible.

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[7] In the case of transportation equipment, the differing results probably come about because several very large firms (General Motors, Ford, International Harvester, and Boeing) all showed a greater impact for $\Delta(q_{t-1}/\bar{q})$, whereas most other firms showed a greater impact for $\Delta(Q/Q_m)_{t-1}$. The large firms are given greater weight in the aggregated industry analysis.

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