Fundamental Value and Investment: Micro Data Evidence

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*** Abstract ***

This paper examines the effect of stock prices on investment decisions by investigating individual firm data from COMPUSTAT and designing various proxies for market fundamentals. Our proxies are based on: (i) the dividend approach; (ii) the dividend smoothing approach; (iii) the earnings approach.

From the aggregated COMPUSTAT micro data, we find that corporate managers respond more to market fundamentals than to market valuations. Results from the panel regressions, on the other hand, turn out to be not helpful, since most of the explanatory power of the investment regression is derived from the individual firm specific effect. Our findings are either a reflection of the substantial measurement error in micro data, or they suggest a kinked adjustment costs of investment at the micro level.

** We are thankful to William Brainard and Matthew Shapiro for providing us their RATS program for the construction of Tobin's q series and Thomas Cooley for letting us to access COMPUSTAT Tapes at Simon School, University of Rochester.

I. Introduction

Stock prices and fixed investment should be closely related as long as stock market participants and corporate managers base their decisions on market fundamentals. Suppose, however, that stock prices are affected by irrational waves of optimism and pessimism, and do not solely reflect the fundamentals. When making investment decisions, do corporate managers ignore stock prices if they have good reason to believe that market prices deviate from fundamental values? The implications of an affirmative answer are important. If managers see through the veil of bubbles, the stock market - even if it is virtually a casino as Keynes described - can still be an efficient resource allocation mechanism. Inefficient stock market may have an impact on wealth redistribution among speculators, but not on real economic activity.

As discussed in previous studies (Fischer and Merton (1984), Blanchard, Rhee, and Summers (1990), Morck, Schleifer, and Vishny (1991)), the above question raises many conceptual issues, and theory alone does not seem to provide an unambiguous answer. On the empirical side, the evidence so far is not clear either. The problem is that we cannot observe market fundamentals, so the use of a proxy in empirical studies necessarily biases the estimates.

This paper searches for clearer evidence on the above question by investigating individual firm data from COMPUSTAT and designing theoretically sophisticated proxies for market fundamentals. In the previous literature (e.g., Blanchard et. al. (1990), Galeotti and Schiantarelli (1989), Morck et. al.(1991)), simple proxies such as current dividends, net cash flows, and the predicted value of future dividends are used for market fundamentals. The cost of using such simple proxies is the possible presence of a large errors-in-variables problem. For instance, as pointed out by

Kleidon (1986) and others, current dividends are biased estimators of market fundamentals when dividends are nonstationary; If one considers the information content of dividend smoothing policies, changes in dividends, not the level of dividends, may be a better proxy for market fundamentals.

In this paper, we explicitly consider issues of nonstationarity and dividend smoothing in constructing various measures of market fundamentals. These measures are based on: (i) the dividend approach developed by Campbell and Shiller (1987, 1988); (ii) the dividend smoothing approach developed by Lintner (1956), Marsh and Merton (1986), and Mankiw, Romer, and Shapiro (1989); (iii) the earnings approach developed by Miller and Modigliani (1961). Our strategy is to then compare the relative performance of market valuation (or stock prices) and our measures of market fundamentals in explaining fixed investment. The performance of other proxies such as net cash flows and sales are also compared.

Our empirical results are based on COMPUSTAT data of 297 companies existing between 1963 and 1988. From the *aggregated* micro data, we find that corporate managers respond more to fundamentals than to market valuation, strengthening the results which Blanchard et. al. (1990) found from macro data. However, the explanatory power of market valuations, after controlling for market fundamentals, is not negligible. The point estimates are significant, and the additional explanatory power is approximately one third of that of market fundamentals. Whether this is due to a portion of fundamentals which is not captured by our proxies, or a genuine effect of bubbles, is an unsettled issue.

On the other hand, results from the panel regressions surprisingly suggest that information at the individual firm level is *not* helpful in clarifying the role of stock prices in investment decisions. In investment equations, the explanatory power of both fundamentals and market valuations is negligible. Most of the explanatory power in the investment regression is derived from the firm specific effect. The combined explanatory power of fundamentals and market valuations is at most five percent. After examining alternative variables suggested by various theories of investment, we conjecture that the different performance of investment equation between the firm level and the aggregated level reflects the substantial measurement error in our COMPUSTAT data.[1] However, before we have a theory of firm specific effects, we are reluctant to base our conclusions about the relative importance of fundamentals and bubbles at the micro level on such small explanatory powers.

The rest of the paper is organized as follows. Section II briefly reviews the conceptual issues, and lays out our empirical approach. Various measures of market fundamentals and the theories behind them are discussed in section III. Section IV presents regression results from the aggregated micro data; and regression results from the panel data are reported in section V. Section VI contains concluding remarks. The appendix which explains the construction of the "Tobin's q" series from COMPUSTAT data is available by request.

II. Do only fundamentals matter?

II.1 conceptual issues

What should corporate managers do if their valuation of an investment project differs from that provided by the stock market? Instead of reviewing the theoretical arguments in detail, we summarize few of the conceptual issues which make the

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1 Since the time series of the aggregated COMPUSTAT data and the macro data show very similar behavior, we conclude that there is no sample selection bias in using the COMPUSTAT data.

theoretical answer ambiguous.

(1) Financing Decision vs. Investment Decision

The stock market is a place where firms issue new shares to raise capital, and the market price of these shares determines the cost of capital: the higher the price, the lower the cost of capital. Therefore, as pointed out by Fischer and Merton (1984), if managers believe that equity prices are high relative to market fundamentals, the firm could increase its capital inexpensively by issuing new shares. Blanchard et al.(1990), however, noted that proceeds from new equity issues need not be invested in physical capital. The managers' best strategy may be to issue new shares and invest the proceeds in financial assets, (e.g., Treasury Bills) which is equivalent to investing in a constant returns to scale technology. Irrational stock prices may affect financing decisions, but not necessarily physical investment decisions.

(2) Managers' Objectives

The corporate managers' response to a difference between perceived fundamentals and market valuations will largely depend on their objectives. For example, if the myopia of short term shareholders ties the managerial compensation to the short run performance of the stock, managers have an incentive to follow the market's judgment rather than their own evaluations of investment projects (Stein (1988, 1989), Schleifer and Vishny (1990)). On the other hand, managers who are concerned with the interests of long term shareholders might abstain from responding to irrational fluctuations in stock prices.

(3) Imperfect Information and Adjustment Cost

Investing in physical capital is generally irreversible and involves more adjustment costs than investing in financial assets. Therefore, when it is not certain whether a particular change in stock prices reflects an irrational wave or a change in fundamentals, managers are more likely to invest in financial instruments rather than physical capital. Employing similar reasoning, managers with easily adjustable capital will be more aggressive in taking advantage of irrational stock prices.

Since theory alone does not unambiguously answer the questions posed in our introduction, we turn next to empirical methods to resolve it.

II.2 Test Strategies

Consider a simple model in which investment responds to market fundamentals and/or bubbles[2]:

$$I/K = a1 + b\ F + c\ B\ , \tag{1}$$

where F and B represent market fundamentals and bubbles, respectively. If F and B were observable, hypothesis testing would be simple. Under the hypothesis that managers respond only to market fundamentals (the managerial perception hypothesis), only F should be significant, i.e., $b > 0$ and $c = 0$. Under the hypothesis that investments respond to the stock market valuation, which is the sum of F and B, (the market perception hypothesis), both F and B should have the same effect on investment, i.e., $b = c > 0$.[3] We can also think of a weaker version of the managerial perception hypothesis in which the managers respond more to market fundamentals than to bubbles, i.e., $b > c \geq 0$. We will call the former the strong managerial hypothesis

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2 For brevity, "bubble" in this paper refers to any non-fundamental portion of stock prices, whether it is due to fads, rational bubbles, investors sentiments, etc.

3 Assume that each variable is log transformed so that the coefficients b and c measure elasticities which are independent of the units of F and B.

and the latter the weak managerial hypothesis.

Unfortunately, F and B are unobservable. Suppose that econometrician can observe the stock market's assessment of firms' investment (denoted by M) and a proxy for market fundamentals (denoted by T). Assume that M and T are related to the unobservable F and B as follows:

$$M = a2 + F + B \ , \tag{2}$$

$$T = a3 + F + e \ , \tag{3}$$

where e represents specification error. With (2) and (3), we can think of a "signal extraction" problem in which econometrician estimates F as a linear predictor on M and T. More specifically, F can be written:

$$F = a4 + \alpha \cdot M + \beta \cdot T + \varepsilon, \tag{4}$$

where ε is a forecasting error which is orthogonal to M and T. Using equations (2) and (4), we can rewrite equation (1) to eliminate the unobservable F and B.

$$I/K = k1 + k2 \cdot M + k3 \cdot T + \nu, \tag{5}$$

where $k1 = a1 + (b-c)a4 - c \cdot a2$, $k2 = \alpha(b-c) + c$, $k3 = \beta(b-c)$, and $\nu = (b-c)\varepsilon$.

Thus, by regressing I/K on M and T, we can test the managerial perception hypothesis versus the market perception hypothesis by examining the estimate of k3. Under the market perception hypothesis, $b = c$ implies $k3 = 0$. Under the managerial perception hypothesis, k3 would be positive given that β is likely to be positive. Our estimation, however, cannot precisely extract the effect of bubbles, c. The estimator k2 is a biased estimate of c since M contains information about fundamentals which T does not capture perfectly.

III. Construction of fundamental values

In this section, we construct various measures of fundamental value of equity based on three theoretical models. The estimated fundamental value of equity replace the market value of equity in calculating the fundamental q series. The market value of debt, on the other hand, is assumed to be equal to its fundamental value. Since bonds have fixed maturities and their dividends (coupons) are known a priori, there exists little room for bubbles in bond prices. Empirically, it is well documented that bond prices are relatively better explained by the simple present value model than stock prices. Moreover, since more than three quarters of the variation in the q is due to the valuation of equity, the bias, if any, from not considering the fundamental value of debt must be small.

III.1 The Dividend Approach

Consider a simple present value model,

$$P_{t,i} = \sum_{j=0}^{\infty} \delta_i^{j+1} E_t D_{t+1+j,i} \,, \qquad (6)$$

where $D_{t,i}$ is the dividend per share during the year t, and $P_{t,i}$ is the stock price of firm i at the end of the year t. To simplify the notation, the subscript i will be omitted in the rest of the paper. When P_t is first difference stationary, Campbell and Shiller (1987, 1988) show that the present value model (6) implies that the actual spread, S_t, forecasts a weighted average of expected future changes in dividends[4];

$$S_t \equiv P_t - \frac{\delta}{(1-\delta)} D_t = \frac{\delta}{(1-\delta)} \sum_{j=1}^{\infty} E_t[\delta^{j-1} \Delta D_{t+j}]. \qquad (7)$$

4 By using the cointegrated vector autoregression approach, a possible bias due to nonstationarity of dividends is taken into account.

We define the expression on the far right of equation (7) (the weighted average of expected future changes in dividends) as the theoretical spread S'_t. To estimate S'_t, we assume that a column vector $X_t = [\Delta D_t, S_t, O_t]$ follows a second order VAR, where O_t denotes other potential predictors of S'_t. In a succinct companion form,

$$Z_t = A \cdot Z_{t-1} + u_t, \quad \text{where } Z_t = [\Delta D_t, \Delta D_{t-1}, S_t, S_{t-1}, O_t, O_{t-1}]. \tag{8}$$

Under assumption (8), S'_t can be represented as;

$$S'_t = \frac{\delta}{(1-\delta)} e1' A[I-\delta A]^{-1} Z_t, \tag{9}$$

where e1 is a column vector whose number of elements is equal to the number of variables in Z_t, and all the elements in e1 are zero except for the first element, which is unity. By substituting an unrestricted VAR estimate of the companion matrix A into (9), we can estimate the theoretical spread S'_t. Then, from (7), our fundamental stock prices P'_t can be estimated by;

$$P'_t = S'_t + \frac{\delta}{(1-\delta)} D_t . \tag{10}$$

For the discount factor δ_i of company i, we use the mean real return from holding its shares. Using the PPI as a price index, the average discount rate for the whole sample is 7.48 percent.[5] To reflect the cost of capital and the ability of (a moving average of) earnings to forecast changes in dividends, we include the BAA rate and earnings per share in our VAR analysis.

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[5] Using the CPI as a price index, the corresponding figure is 4.03 percent. High discount rate versus low discount rate was one of the central issues in the debate about stock market volatility. It does not, however, qualitatively affect our results. Therefore, we report the case of the PPI only. Using the discount rate inferred from the cointegration regression was not feasible. We got negative discount rates for around one fifth of the data set.

III.2 The Earnings Approach

One of the controversial issues in finance concerns whether earnings or dividends determine the underlying value of a firm. Miller and Modigliani (1961) show the case in which the underlying value of a firm is based on earnings, not dividends: dividend policies are shown not to affect the value of a firm. Under their assumptions, irrespective of the financing method, the value of equities is given by;

$$V_t = \sum_{j=0}^{\infty} \delta^{j+1} E_t[\, \epsilon_{t+1+j} - I^n_{t+1+j} \,], \tag{11}$$

where ϵ_t and I^n_t are earnings and net investment, respectively.[6] By assuming that the column vector $X_t = [V_t, \ \epsilon_t - I^n_t]$ follows a second order VAR, we apply Campbell and Shiller's cointegrated VAR to equation (11) in order to estimate the fundamental value of equities. Note that this approach estimates a firm's fundamental value of equities rather than individual stock price.

III.3 The Dividend Smoothing Approach

Lintner's view (1956) that corporate managers try to smooth out dividend payments has been supported by subsequent empirical studies. One of the important implications of the dividend smoothing hypothesis is that dividends play a signaling role. If managers change dividends only when permanent earnings have changed, dividend changes are likely to convey inside information to the public. Contrary to Miller and Modigliani (1961), dividend policy is not irrelevant as it affect share prices. This raises the possibility that the dividends approach and the earnings approach may not be equivalent.

6 Since our earnings variable does not include interest payments on bonds, equation (11) measures the value of equities instead of the value of the firm.

In many dividend smoothing models (Marsh and Merton (1986), Mankiw, Romer, and Shapiro (1989)), the actual change in dividends is represented as a proportion of the desired change;

$$\Delta D_t = a + (1-\mu)(\rho\eta_t - D_{t-1}) + u_t \tag{12}$$

where ρ and μ are the long-run target payout ratio and speed of adjustment, respectively, and η_t is the earnings per share during year t. If the earnings process, η, follows a logarithmic random walk, the dividend process (12), and the simple present value model in (6) imply that the fundamental stock price can be given by;

$$P'_t = \delta \left[\frac{\mu}{1-\delta\mu}(D_t - \rho\eta_t) + \rho\eta_t \frac{1}{(1-\delta)} \right] . \tag{13}$$

In our sample, the mean of the speed of adjustment and the target payout ratio are estimated to be 0.902 and 0.6, respectively.[7] These figures are similar to those estimated by Fama and French (1988) from the CRSP data.

IV. Evidence from the aggregated micro data

Our sample consists of the 297 companies on the COMPUSTAT tape from 1963 through 1988. After adjusting for the lead and lags in the VAR, our regression sample period covers 1966 to 1987. In the appendix (available by request), we describe sample exclusion criteria, definitions of the variables, and the construction of Tobin's q

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7 Parameters μ and ρ can be estimated by running an OLS regression, $\Delta D_t = a + (1-\mu)\rho\eta_t - (1-\mu)D_{t-1} + u_t$. The estimated mean speed of adjustment and the mean target payout ratio were -0.235 and 0.417, respectively. The negative estimate on the mean speed of adjustment may be due either to the downward bias from nonstationarity of earnings and dividends, or the endogeneity of earnings. Instead of running the two stage regression, we did a grid search for ρ, the target payout ratio, subject to the restriction that $0 \le \mu < 1$. This resulted in the values $\hat{\rho}=0.6$ and $\hat{\mu}=0.902$.

(market q).[8]

Some descriptive statistics are reported in table 1; in this table, q1 is the market q and q2, q3, and q4 are the fundamental q series. As discussed in the previous section, the fundamental q's are constructed based on the dividend approach (q2), the dividend smoothing approach (q3), and the earnings approach (q4). The time series of the cross section average of each q series are plotted in figure 1.

To check for possible sample selection bias, we compare the time series of our aggregated micro data with the macro data. We use the macro data set constructed by Blanchard et al. (1990) using the NIPA and the Flow of Funds data. The aggregated micro time series refers to the sample averages of the micro data in each year. In figure 2 and 3, the aggregated market q and investment to capital ratio (I/K) are plotted with their macro counterparts.[9] The correlation coefficient between the aggregated market q and its macro counterpart is 0.83; the coefficient between the micro and macro I/K's is 0.76. Clearly, our sample shows close comovement with its macro equivalents.

Table 2 compares the performance of aggregated micro measures of q and other variables in explaining investment. In each case, regressions are run in the first difference of logarithms, since error terms are highly correlated in the level specification. In order to consider a time to build and to avoid simultaneity problems, investment during year t is regressed on independent variables at the end of year t-1.[10] Our main independent variables are the market q and the three

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8 Brainard and Shapiro kindly provided their RATS program for the construction of Tobin's q used in Brainard, Shapiro, and Shoven (1990). Our construction is based on their method with minor modifications.

9 We standardize each series, i.e., subtract the mean and divide by its standard deviation, so that this plots have comparable variation.

10 Including more lagged variables leaves the main results unchanged.

fundamental q's. We also examines the net cash flow over capital[11], sales over capital, and real stock returns. From these regressions several features are notable.

The first four columns in table 2 report the performance of the market q and the three fundamental q series in explaining changes in investment. The fundamental q series, except the dividend based q2, perform reasonably well. The low explanatory power of q2 suggests that dividends alone are not a sufficient statistic for the present discounted value of profits. Among the q series, q3 (based on the dividend smoothing approach) performs best. Its R-squared, 30 percent, is better than those the market q and the earnings based q4, and comparable to those of net cash flow and real stock returns.[12] Considering that all proxies are based on the same simple present value model, the performance of q3 is positive evidence for the hypothesis which emphasizes the signaling role of dividend smoothing policies.[13]

The R-squared of net cash flow, on the other hand, is somewhat higher than that of q3. Though not reported in the table, the better performance of net cash flow over other proxies is also confirmed using the macro data from Blanchard et al. (1990). This is somewhat discouraging since our structural proxies are clearly preferable from a theoretical point of view.

However, the role of net cash flow in investment regressions is ambiguous. In

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11 Net cash flow (NCF) is constructed as follows: NCF = after tax income before extraordinary items + book value of depreciation and amortization + interest expense - interest expense of non-bond current debt - inventory valuation adjustment - current value of economic depreciation.

12 The order of performance among these variables, however, is not robust across sub groups such as different industries, etc..

13 Barro (1990) has argued that the real return on stocks strictly dominate changes in q in explaining changes in investment. Morck, Schleifer, and Vishiny (1990) use Barro's argument for justifying their unstructured approach of using real stock returns instead of q. However, we find that the aggregated micro q and real stock returns do not dominate each other in our micro data.

addition to capturing market fundamentals, the significance of net cash flow may also capture the imperfect substitutability, due to liquidity constraints, between internal and external sources of finance. In order to disentangle these two possible roles of net cash flow, we compare the investment behavior of individual firms. Individual firms are classified according to company size and dividend payout rates as suggested by Fazzari et al. (1988)

Group I consists of high dividend payout firms, whose average dividend-earnings ratio belongs in the top 30 percent. Group II consists of firms with a dividend earnings ratio in the bottom 30 percent. Some descriptive statistics for these groups are reported in the second and third columns of table 1. Firms in Group II, the lower dividend payout firms, are arguably more liquidity constrained, and hence should have a high sensitivity of investment to net cash flow. The elasticities of investment to net cash flow are reported in the eighth and ninth columns of table 2 for Groups I and II, respectively. In contrast to the evidence in Fazzari et al. (1988) the elasticity of investment is not greater for group II than for group I. Classification by firm size did not reveal greater sensitivity either. These results suggest that, while it is hard to think of a structural interpretation, the net cash flow can qualitatively be used as another proxy for market fundamentals.

The regressions reported in table 3 test the main hypothesis of this paper that managers respond more to fundamentals than to bubbles when making investment decisions. To test this hypothesis, we estimate the equation (5) derived in section II.2. The positive coefficients of the fundamental q variables provide evidence favoring the hypothesis that investment responds more to market fundamentals. However, the point estimates of the coefficient of the market q indicate that bubbles still have some effect on investment. In fact, the additional explanatory power of the market q is impressive: even after controlling for the two proxies for market fundamentals, q3 and net cash flow, the market q variable increases R-squared by 13 percent, which is 21 percent of total R-squared.[14] Whether this additional explanator power is due to large errors-in-variables or a genuine effect of bubbles is an unsettled issue. Our proxies, for instance, do not capture the change of market fundamentals caused by time varying discount rates.

Our estimate of the additional explanatory power of the market q (and the real stock price) after controlling for fundamentals is much higher than what Morck et al. (1990) found using the same Compustat data.[15] The difference comes mainly from our excluding the contemporaneous net cash flow variable in the regression to avoid the simultaneity problem. If the contemporaneous net cash flow variable is included, the incremental R-squared in our regression for the market q is only 4.1 % which is less than one tenth of total R-squared. Because of the simultaneity bias, we think 4.1 % is an underestimate of the role of the stock market. If, on the other hand, investment can be adjusted within a year, excluding contemporaneous variables in our annual estimation may overestimate the role of the stock market: Unlike lagged q or stock prices, lagged net cash flow cannot reflect the expected current and future profits.[16]

In sum, our evidence convincingly and robustly suggests that investment responds

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14 Using the real stock price index instead of the market q variable provides a similar conclusion.

15 Their estimate of the additional explanatory power is around one tenth of total R-squared.

16 In their atheoretical approach, Morck et al. (1990) attempted to provide maximum scope for the stock market to affect investment by avoiding a structural approach such as q theory. However, the simultaneity bias due to contemporaneous variables in their regression makes it difficult to decide whether their specification indeed allows for maximum scope for the stock market.

more to market fundamentals than bubbles. However, whether bubbles have an influence on investment is still controversial. Estimates of the incremental explanatory power provided by the market q or the real stock price ranges from one tenth to one fifth of the explanatory power of market fundamentals.

V. Evidence from Panel Data

Some of the conceptual issues discussed in section II.1, such as managerial myopia, are more plausible at the individual firm level than the aggregated level. To investigate the role of bubbles at the firm level, we turn to the panel regressions. Since our test needs a logarithmic specification, the data include 141 companies, after removing all the firms that have observations of negative q's and/or negative net after tax cash flows.[17]

Results of the panel regressions with individual firm specific effects are reported in table 4.[18] Even though the R-squareds are fairly high (30-35%), most of the explanatory power is derived from individual firm specific dummies. The incremental explanatory power of all other variables is less than 5 %. Without introducing fixed effects, only net cash flows have a decent explanatory power of 13 %. In table 5, regressions are run in first differences to remove the fixed effects; the results confirm that our independent variables leave most of the variance of investment unexplained. The maximum R squared (7.8%) in the first difference specification is obtained when the sales to capital ratio is a regressor. For the other variables the R squares are less than 4 %. Even the explanatory power of the

17 Regressions in levels including all 297 companies do not change the qualitative conclusions, except that the R-squareds are around 25 percent.

18 An autocorrelated error structure leaves the results unchanged. The estimated autocorrelation coefficient is around 0.22.

sales to capital ratio drops to 3 percent once the serial correlation in the error terms is corrected. Though not reported, including more lagged independent variables does not change the results.[1]

The weak performance of investment equations at the micro level is not unique to q theory. For instance, net cash flows in our regressions can be regarded as representing the liquidity constraint theory of investment; the sales to capital ratio represents the accelerator theory; real stock prices and net cash flows are the variables mostly used in atheoretical approaches. At the micro level, however, these variables leave most of the changes in investment unexplained.[2]

In sum, the explanatory power of market fundamentals, not to mention the effect of the market valuation, is negligible in panel regressions. Without explaining the firm specific effect, we are reluctant to compare the relative importance of fundamentals and bubbles based on such a small explanatory powers. Though we started this project with a hope that a richer data set, such as panel data, would provide clearer answers to our questions, panel regressions turn out not to be helpful, and

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1 Morck et al. (1990) also found that the explanatory power of all variables is quite low when investment growth equations are estimated annually. By arguing that a one-year period may be too short to capture delayed changes in investment, they use the three year growth rate of investment as the dependent variable. However, we think that a more plausible way to consider delayed response of investment is to include more lagged independent variables with the one year growth rate of investment as the dependent variable.

2 It is well known that expenditure on consumer durables, which can be regarded as a form of investment, approximately follows a random walk (Mankiw (1982)); i.e., other variables can not explain its growth rate as we found in our case of investment expenditures. Recently, Caballero (1990) showed that a delayed response of consumers to news might explain finding a random walk approximation; once a nonparsimonious approach is used, or low frequencies of the data are examined, he finds that expenditure on consumer durables does not follow a random walk. This explanation does not apply to our case for two reasons. First, as reported in section IV, our independent variables explain investment quite well at the aggregated micro data level. Second, even at the firm level, the nonparsimonious approach did not improve the estimation.

are therefore not reported.[3]

The different performance of the investment equation between the firm level and aggregate level may either reflect substantial measurement errors in micro data, which cancel out in aggregate data, or the lack of an adequate theory of investment. To our knowledge, panel data, such as the PSID, which is widely used in the consumption and labor literature, does not seem to show drastic differences between individual and aggregate level. This may reflect the relatively more difficult task of accurately measuring capital stocks as opposed to consumption expenditures or labor supply. Another conjecture for this difference may be a kinked adjustment costs of investment; if investment is irreversible or there are lump-sum costs of investment, the dynamic behavior of investment can be very different between the firm level and aggregate level (Arrow (1968), Bertola (1989), Bertola and Caballero (1990)). Investment at the firm level will occur infrequently. However, if the timing of each firm's lumpy investment is staggered enough, aggregate investment could be characterized by smooth adjustment, as in the standard multiplier-accelerator models and as in q theory.[4]

VI. Conclusion

In making investment decisions, do managers follow the signals given by the

3 This finding makes us doubt the results of previous investment literature which used panel data. For instance, Fazzari et al. (1988) and Hoshi et al. (1991) examine the relative performance of Tobin's q and net cash flow to test the implication of liquidity constraints using the Value Line data and the data from 145 Japanese manufacturing firms, respectively. Since they did not report the R squared without firm specific effects, we cannot guess as to the size of the explanatory power of their independent variables. However, if they were as low as in our Compustat data, judging the relative performance of q and net cash flows by examining only t-statistics would not be a powerful test.

4 The first author is currently testing a kinked adjustment costs model of investment using panel data.

stock market even if their own valuation of the investment project does not coincide with the stock market valuation? The previous literature on this topic finds ambiguous answers, and their use of atheoretical proxies for market fundamentals and/or macro data has been criticized as possible reasons for the ambiguity. This paper searches for clearer evidence by investigating individual firm data from COMPUSTAT and designing theoretically rigorous procedures for separating fundamentals and bubbles.

From the *aggregated* COMPUSTAT micro data, we find that corporate managers respond *more* to market fundamentals than to market valuations. However, whether market valuations, after controlling for market fundamentals, still affect investment is an unsettled issue.

Results from the panel regressions, on the other hand, surprisingly suggest that our panel data are *not* helpful for testing the hypotheses. In investment equations, the explanatory power of both fundamentals and market valuations is negligible. Since most of the explanatory power of the investment regression is derived from the individual firm specific effect, we are reluctant to form any conclusion at the individual firm level. Our findings are either a reflection of the substantial measurement error in micro data, or they suggest a kinked adjustment costs of investment at the firm level.

Table 1: Descriptive Statistics

	Total Sample	Group I	Group II
Number of firms	297	82	81
mean q1	1.32 (1.33)	1.51 (1.97)	1.21 (0.97)
mean q2	1.38 (1.32)	1.56 (2.00)	1.28 (0.89)
mean q3	0.48 (0.77)	0.76 (0.99)	0.37 (0.50)
mean q4	1.50 (2.07)	1.53 (2.25)	1.72 (2.98)
mean Investment/K	0.10 (0.05)	0.10 (0.05)	0.11 (0.06)
mean net cash flow/K	0.06 (0.03)	0.06 (0.04)	0.06 (0.03)
mean debt/K	0.25 (0.20)	0.23 (0.13)	0.32 (0.22)
mean dividend/K	0.03 (0.05)	0.05 (0.07)	0.01 (0.01)
mean earnings/K	0.08 (0.10)	0.09 (0.12)	0.08 (0.07)
mean dividend/earnings	0.48 (0.63)	0.93 (1.00)	0.16 (0.10)
mean K (1982 dollars)	1325 (3713)	2288 (5372)	377 (1030)

1. Figures in parenthesis are standard errors.
2. All variables are evaluated by market values, not book values.
3. Group I consists of high dividend payout firms, whose average dividend-earnings ratios belong in the top 30 percent. Group II consists of firms whose dividend-earnings ratios belong in the bottom 30 percent.
4. q1: Tobin's q.
   q2: fundamental q from the dividend approach.
   q3: fundamental q from the dividend smoothing approach.
   q4: fundamental q from the earnings approach.

Table 2: Regressions with The Aggregated Micro Data (I)

Dependent Variable: $\Delta\log(I(t+1)/K(t))$
Sample period: 1967-87

independent var:	1	2	3	4	5	6	7	8	9
			All Samples					GroupI	GroupII
$\Delta\log(q1(t))$	0.33 (.13)								
$\Delta\log(q2(t))$		0.06 (.78)							
$\Delta\log(q3(t))$			0.31 (.11)						
$\Delta\log(q4(t))$				0.71 (.39)					
$\Delta\log(NCF(t)/K(t))$					0.58 (.18)			0.48 (.23)	0.14 (.09)
$\Delta\log(sales(t)/K(t))$						1.85 (.84)			
$\Delta\log(P(t))$							0.39 (.13)		
R^2	.24	.00	.30	.14	.33	.20	.29	.18	.10
D.W.	1.68	1.94	2.22	2.01	2.43	2.51	1.71	2.57	2.28

1. Figures in parenthesis are standard errors.
2. Constant terms are not reported.
3. q1: Tobin's q.
   q2: fundamental q from the dividend approach.
   q3: fundamental q from the dividend smoothing approach.
   q4: fundamental q from the earnings approach.
   NCF: net cash flows
   P(t): real stock prices

Table 3: Regressions with The Aggregated Micro Data (II)

Dependent Variable: $\Delta\log(I(t+1)/K(t))$
Sample period: 1967-87

independent var:	1	2	3	4	5	6	7
$\Delta\log(q1(t))$	0.30	0.32	0.23	0.32			0.25
	(.11)	(.12)	(.12)	(.11)			(.11)
$\Delta\log(q3(t))$	0.29					0.20	0.22
	(.09)					(.11)	(.10)
$\Delta\log(q4(t))$		0.67					
		(.34)					
$\Delta\log(NCF(t)/K(t))$			0.46		0.43	0.41	0.26
			(.18)		(.18)	(.20)	(.19)
$\Delta\log(sales(t)/K(t))$				1.75			
				(.73)			
$\Delta\log(P(t))$					0.27		
					(.13)		
R^2	.50	.37	.44	.42	.45	.42	.55
D.W.	1.94	1.92	2.17	2.31	2.17	2.36	2.06

1. Figures in parenthesis are standard errors.
2. Constant terms are not reported.
3. q1: Tobin's q.
   q3: fundamental q from the dividend smoothing approach.
   q4: fundamental q from the earnings approach.
   NCF: net cash flows
   P(t): real stock prices

Table 4: Panel Regressions with Fixed Effects

Dependent Variable: log(I(t+1)/K(t))
Sample period: 1967-87

independent var:	1	2	3	4	5	6	7
log(q1(t))	0.22 (.02)						
log(q2(t))		0.13 (.03)					
log(q3(t))			0.06 (.02)				
log(q4(t))				0.03 (.02)			
log(NCF(t)/K(t))					0.32 (.02)		
log(sales(t)/K(t))						0.66 (.05)	
log(P(t))							0.22 (.02)
R^2							
fixed effect only:	0.31	0.31	0.31	0.31	0.31	0.31	0.31
indep. variables:	0.06	0.03	0.01	0.03	0.13	0.00	0.04
total:	0.34	0.31	0.31	0.31	0.35	0.35	0.34

1. Figures in parenthesis are standard errors.
2. Constant terms are not reported.
3. q1: Tobin's q.
   q2: fundamental q from the dividend approach.
   q3: fundamental q from the dividend smoothing approach.
   q4: fundamental q from the earnings approach.
   NCF: net cash flows
   P(t): real stock prices

Table 5: OLS Regressions: First Differences of Panel Data

Dependent Variable: $\Delta\log(I(t+1)/K(t))$
Sample period: 1967-87

independent var:	1	2	3	4	5	6	7
$\Delta\log(q1(t))$	0.35 (.03)						
$\Delta\log(q2(t))$		0.10 (.10)					
$\Delta\log(q3(t))$			-0.12 (.03)				
$\Delta\log(q4(t))$				0.21 (.04)			
$\Delta\log(NCF(t)/K(t))$					0.22 (.02)		
$\Delta\log(sales(t)/K(t))$						1.41 (.09)	
$\Delta\log(P(t))$							0.36 (.03)
R^2	.03	.001	.004	.01	.03	.07	.04
D.W.	2.65	2.62	2.61	2.61	2.67	2.62	2.67

1. Figures in parenthesis are standard errors.
2. Constant terms are not reported.
3. q1: Tobin's q.
   q2: fundamental q from the dividend approach.
   q3: fundamental q from the dividend smoothing approach.
   q4: fundamental q from the earnings approach.
   NCF: net cash flows
   P(t): real stock prices

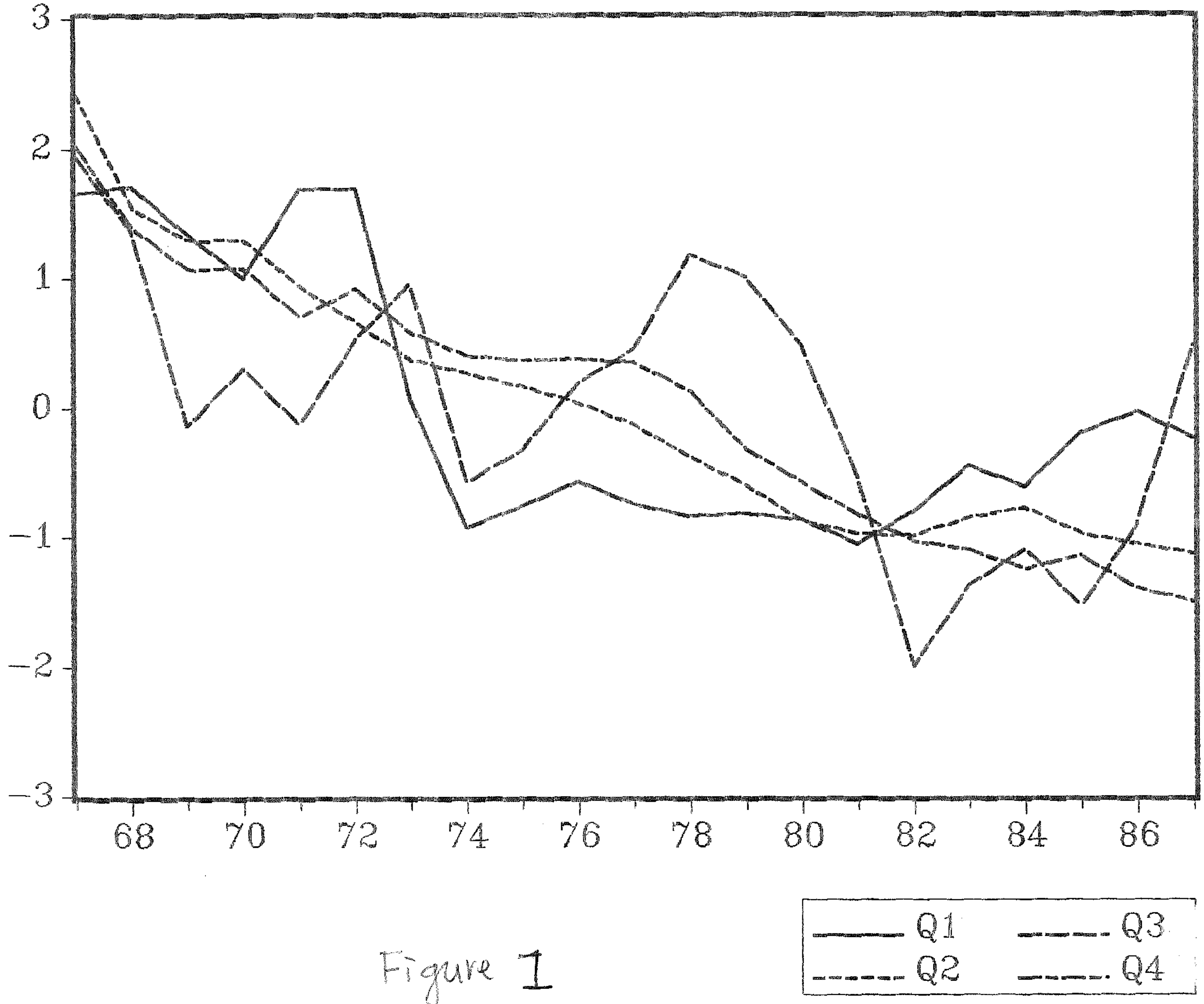
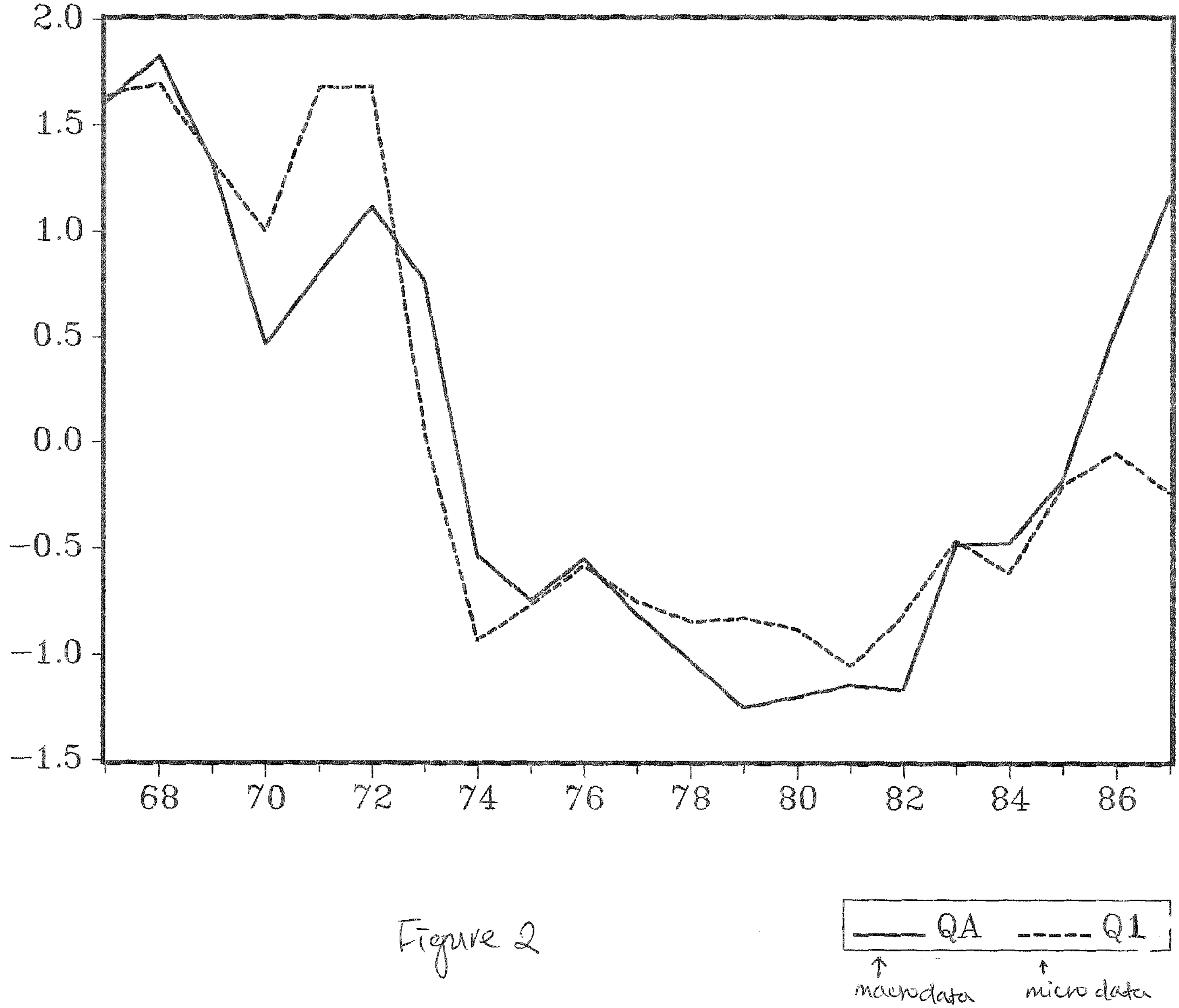


Figure 1



2.0
1.5
1.0
0.5
0.0
−0.5
−1.0
−1.5
68
70
72
74
76
78
80
82
84
86
QA
Q1
macrodata
micro data

Figure 2

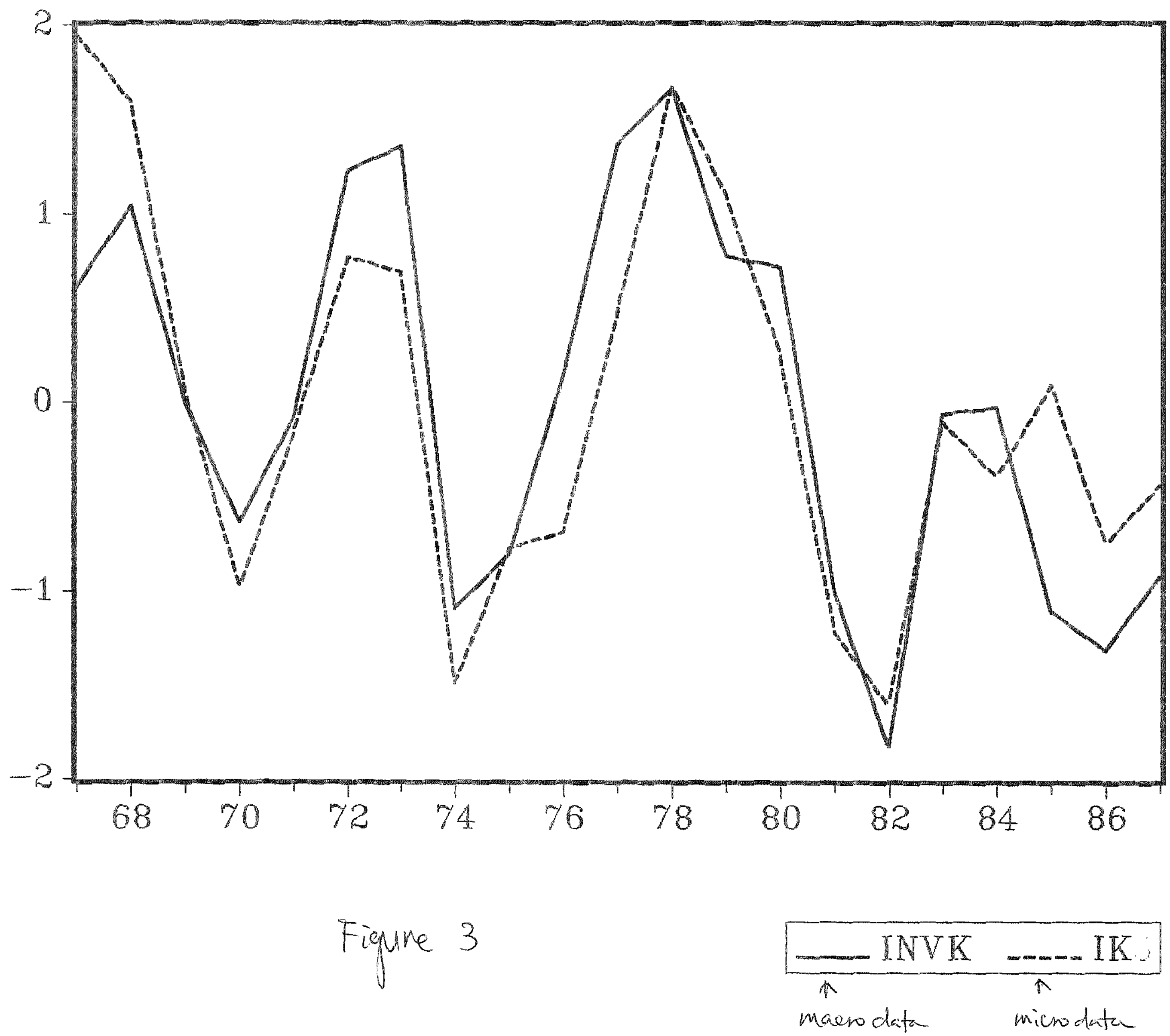


Figure 3

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FUNDAMENTAL VALUE AND INVESTMENT: MICRO DATA EVIDENCE

Appendix: Construction of Tobin's q

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The source of our data is the "CompuStat Merged and Annual Industrial with OTC file" created by the Simon school, University of Rochester. This file is an expanded version of the 20 year "moving window" CompuStat tapes and spans from 1950 through 1988.

We exclude firms whose two digit SIC code is less than 20 or greater than 89, which have negative book value of capital, whose fiscal year end is not December, which have not paid any dividend in the whole sample period, or whose key variables are missing. After the exclusion, our data consist of 319 firms, and most of them have a sample period from the mid 1960s to 1988.

1. Market Value of Equity (VE)

The market value of common stock at the end of the year is estimated by multiplying the closing share price by the number of shares outstanding at the end of year. The market value of preferred stock is estimated by dividing preferred dividends by the Standard and Poor's preferred stock yield.

2. Replacement Cost of Capital (RCNK)

In order to convert the book value of net property, plant, and equipment into the replacement cost, we have to keep track of the vintage of the capital stock. In doing so, we follow closely the method used in Brainard, Shapiro, and Shoven (1988). We assume that (1) the lifetime of equipment is 14 years and the lifetime of structure is 26 years. (2) The proportion of a firm's equipment investment over structure investment is the same as that in the firm's two digit industry. (3) Firms use the straight-line depreciation method. (4) For the history of investment prior to the beginning of the data, investment is assumed to increase at the same rate of capital growth during the first five years of the sample.

Under the above assumptions, each year's gross capital stock is calculated from the previous gross capital stock minus the retirement of the oldest investment, plus new investment and a write-off or write-down of the existing capital by vintage to match the reported gross capital stock. From the estimated vintage history of gross capital stock, net capital stock can be calculated assuming a straight line depreciation. Then, the proportion of equipment investment over total investment is adjusted to minimize the standard deviation of the difference between the estimated and the reported book value of net capital stock. These adjusted book values of net capital stock and depreciation are converted to replacement costs using deflators for equipment and structure in each industry.

The above steps can be summarized using the following definitions:

Define,

$f(t) \equiv fscale \cdot f'(t)$, where $f'(t)$ is a proportion of new equipment investment over total investment. "fscale" is a constant for a grid search, later.

fbar : the average value of $f(t)$ between 1947 and the starting year.

RK(t): reported book value of gross capital. (A7)
RKNT(t): reported book value of net capital. (A8)
a30(t): gross investment.
g: the growth rate of RK(t) during the first five years.
wo(t): write-off or up of existing capital by vintage.
R(t): retirement of the oldest capital stock.
t1: beginning year of the data.
$I_{t+i}(t+i-j)$: investment done at time t+i−j and still outstanding at time t+i.

Then, for the period before t1,

$$RK(t1) - a30(t1) = \sum_{i=1}^{13} I_{t1}(t1-1)(1+g)^{-i+1} + (1-fbar)\sum_{i=14}^{25} I_{t1}(t1-1)(1+g)^{-i+1}$$

$$I_{t1}(t1-j) = I_{t1}(t1-1)*(1+g)^{-j+1} \text{ for } 1 \le j \le 25.$$

For $i \ge 1$, iterate the following equation to generate $I_{t1+i}(t1+i-j)$.

$$R(t1+i) = f(t1+i-14)*I_{t1+i-1}(t1+i-14) + (1-f(t1+i-26))*I_{t1+i-1}(t1+i-26),$$

$$WO(t1+i)=\left[-RK(t1+i)+RK(t1+i-1)+a30(t1+i)-R(t1+i)\right]/\left[RK(t1+i-1)-R(t1+i)\right].$$

Then,

If $WO(t1+i) \ge 0$,

$$I_{t1+i}(t1+i-j) = I_{t1+i-1}(t1+i-j)*(1-WO(t1+i)) \text{ for } 1 \le j \le 26.$$

If $WO(t1+i) < 0$ and $I(t1+i) < 0$,

$$I_{t1+i}(t1+i) = - WO(t1+i)*\left[RK(t1+i-1)-R(t1+i)\right].$$

The estimated net capital stock with straight-line depreciation is ENK(t);

$$ENK(t1+i) = \sum_{j=0}^{25}(1-f(t1+i-j))\ I_{t1+i}(t1+i-j)(1-(j+.5)/26))$$
$$+ \sum_{j=0}^{13} f(t1+i-j)\ I_{t1+i}(t1+i-j)(1-(j+.5)/14)) .$$

Then, find the best "fscale" for each firm by minimizing the standard deviation of the difference between RNK(t1+i) and ENK(t1+i). With $f^*(t) \equiv fscale^* \cdot f'(t)$, replacement cost of net capital, RCNK(t), is;

$$RCNK(t1+i) = \sum_{j=0}^{25}(1-f^*(t1+i-j))\ I_{t1+i}(t1+i-j)(1-(j+.5)/26))\frac{defp(t1+i)}{defp(t1+i-j)}$$

$$+ \sum_{j=0}^{13} f^*(t1+i-j)\ I_{t1+i}(t1+i-j)(1-(j+.5)/14))\frac{defe(t1+i)}{defe(t1+i-j)} ,$$

where defp and defe are price deflator of plant and equipment investment by industry from BLS wealth tape.

3. Replacement cost of inventories (Invval)

In the CompuStat data, seven accounting methods for inventories are listed. For companies using FIFO, Specific identification, Standard costs, and Current and Replacement cost methods, the book value of inventories is assumed to be the market value of inventories. For companies using LIFO, the book value of inventories is adjusted to replacement cost by using the GNP deflator of the two digit industry. For companies using Average cost and Retail method, we assume that half of their inventories are valued by LIFO method. If a firm reports more than one method, we assume that the first method accounts for 2/3 of the reported inventories and the second method accounts for the remaining 1/3. In estimating the replacement cost of LIFO inventories, we follow the detailed description in Salinger and Summers (1983, p275-78).

4. Market Value of Debt (MVD)

In order to estimate the market value of debt, we need to keep track of the maturity structure of long term debt. Following Brainard, Shapiro, and Shoven (1988), we assume that (1) all new issues of long term debt have a 20 year maturity. (2) The coupon rate is the BAA rate in the year of issue and the risk class of the debt does not change until maturity. (4) For the maturity structure prior to the beginning of the data, new issues of long term debt are assumed to increase at the same growth rate of the debt during the first five years of the sample.

Under the above assumptions, each year's estimated book value of the debt is calculated as the previous book value of the debt minus the retirement of the oldest debt, plus new issues of long term debt and early retirements of the existing debt by maturity to match the reported book value of the debt. Given the estimated maturity structure of the debt and coupon rates of original issues, we can calculate the implied interest payments. Then, the proportion of early retirements is adjusted to minimize the standard deviation of the difference between the estimated interest payments and the reported interest payments. The adjusted book value of long term debt by maturity is converted to market value by capitalizing coupon rates. We assume that market value of short term debt is equal the book value.

The above steps can be summarized using the following definitions:

Define,

a9(t): book value of long term debt.

a44(t): book value of short term debt.

a15(t): interest expenses.

a34(t): debt in current liabilities.

g: the growth rate of a9 plus a44 during the first five years.

λ: constant for grid search.

wo(t): early retirement proportion.

t1: beginning year of the data.

$N_{t+j,t+i}$: net issue of long term debt at year t+j, and still outstanding at t+i.

Then, for the period before t1,

$$A9(t1) + A44(t1) = \sum_{j=0}^{19} N_{t1-j,t1} = \sum_{j=0}^{19} N_{t1,t1} (1+g)^{-j} .$$

Since $A44(t1) = N_{t1,t1} (1+g)^{-19}$ by assumption,

$$N_{t1,t1} = A9(t1)*(g/(1+g))/(1-(1+g)^{-19}),$$

$$N_{t1-j,t1} = N_{t1,t1} *(1+g)^{-j} \text{ for } 0 \le j \le 19.$$

For $t \ge t1+1$, maturity structure of debt can be estimated by iterating the following equations:

The above assumptions imply that;

$$A9(t1+i) + A44(t1+i) = N_{t1+i,t1+i} + (1-\lambda-wo(t1+i))\ A9(t1+i-1).$$

Define $\Delta = A9(t1+i) + A44(t1+i) - (1-\lambda)\ A9(t1+i-1)$. Then,
If $\Delta \ge 0$, then

$wo(t1+i) = 0,$
$N_{t1+i,t1+i} = \Delta,$
$N_{t1+i-j,t1+i} = (1-\lambda)\ N_{t1+i-j,t1+i-1}$ for $j = 1, \ldots, 19$.

If $\Delta < 0$, then

$wo(t1+i) = -\Delta/A9(t1+i-1),$
$N_{t1+i,t1+i} = 0,$
$N_{t1+i-j,t1+i} = (1-\lambda-wo(t1+i))\ N_{t1+i-j,t1+i-1}$ for $j = 1, \ldots, 19$.

The implied interest payments (A15hat) from the estimated maturity structure are;

$$\begin{aligned} A15hat(t1+i) = & (A34(t1+i) - A44(t1+i))*BAA(t1+i)/2 \\ & + N_{t1+i,t1+i}*BAA(t1+i)/2 \\ & + N_{t1+i-20,t1+i-1}*BAA(t1+i-20) \\ & + N_{t1+i-19,t1+i}*BAA(t1+i-19) \\ & + \sum_{j=1}^{18} BAA(t1+i-j)*(1+(wo(t1+i)+\lambda))*N_{t1+i-j,t1+i} , \end{aligned}$$

i.e., A15hat is the sum of the interest payments due to;

1. Non bond current debt.

2. new issue of long term debt during t1+i.
3. debt retired during t1+i (short term debt at the end of t1+i-1).
4. debt which becomes short term debt at the end of t1+i.
5. long term debt as of the end of t1+i.

In order to adjust the mean of A15hat and A15, we introduce the variable "premium"; Premium = mean(A15)/mean(A15hat).

Then, we find the best λ which minimizes the standard deviation of the difference between A15 and Premium*A15hat. With the best λ^* and implied maturity structure, we can estimate the market value of debt.

Using BAA rate as coupon and discount rates,
market value of $N_{t1+i-j,t1+i} = MVN_{t1+i-j,t1+i}$

$$= N_{t1+i-j,t1+i} * \left[\frac{BAA(t1+i-j)}{BAA(t1+i)} \left(1-\left(\frac{1}{1+BAA(t1+i)}\right)^{20-j}\right) + \left(\frac{1}{1+BAA(t1+i)}\right)^{20-j} \right]$$

for $j = 0,\ldots,19$, and $i \geq 0$.

Then, market value of long term debt is;

$$MVLD(t1+i) = \sum_{j=0}^{18} MVN_{t1+i-j,t1+i} \quad \text{for } i \geq 0.$$

Instead of using the estimated short term debt ($MVN_{t1+i-19,t1+i}$), we assume that the book value of short term debt (A44) is equal to market value. Then, market value of debt is; MVD(t1+i) = MVLD(t1+i) + A44(t1+i).

5. Miscellaneous Asset Valuation (MV) and Net Asset Valuation (NA)

Market value of net cash, short-term investment, and receivables is assumed to be equal to book value. Other assets at historical cost are treated like LIFO inventories. For book value of net asset (NA) and miscellaneous asset (BMV), the following variables are used.

NA(t) = A4-A3-A5+A44, BMV(t) = A31+A32+A33+A69-A75-A35-a38, where
A4: Current Assets - Total
A3: Inventories
A5: Current liabilities - Total
A44: Debt due in one year. (Note A44 is included in A5.)
A31: investments and advances - equity method
A32: investments and advances - others
A33: intangibles
A69: Asset other
A75: Liabilities -other
A35: Differed Taxes and Investment Tax Credit
A38: Minority interest

6. Construction of q.

$$q = \frac{VE(t) + MVD(t) - MV(t) - NA(t)}{RCNET(t) + Invval(t)} .$$

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