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Discussion of "The Role of Volatility in Forecasting"

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Minton, Schrand and Walther (2002) (MSW) investigate whether cash flow (earnings) volatility helps predict subsequent levels of cash flow (earnings). Price is the present value of expected future cash flows, so if cash flow volatility forecasts future cash flows (the numerator in the present value calculation), it should have valuation implications. A similar motivation applies to earnings, which may be viewed as a proxy for cash flow.

Most previous studies that investigate the valuation implications of cash flow volatility or earnings volatility focus on the relation between volatility and the cost of capital (i.e., the denominator in the present value calculation). Many studies have documented a positive association between earnings volatility and risk measures such as market beta (e.g., Beaver, Kettler and Scholes, 1970). Indeed, in a survey of research relating accounting numbers to systematic risk, Ryan (1997) argues that earnings variability has historically been the accounting variable most strongly related to systematic equity risk.[1] Other studies have reported a negative relation between earnings volatility and the earnings coefficient in either price or return regressions (e.g., Collins and Kothari, 1989; Easton and Zmijewski, 1989; and Barth, Elliott and Finn, 1999). These studies attribute the negative relation between earnings volatility and the earnings coefficient to the positive association between earnings volatility and the cost of equity capital.

To my knowledge, MSW is the first study that directly examines the relation between cash flow volatility and subsequent cash flow levels. The authors hypothesize that cash flow volatility is negatively related to future cash flows because market imperfections induce a wedge between the costs of internal and external funds, and hence cash flow volatility increases the likelihood of underinvestment (relative to the cost of internal funds). Indeed, it appears that firms' investment decisions are sensitive to the source of funding. For instance, using data from the 1986 oil price decrease, Lamont (1997) shows that oil companies significantly reduced their non-oil investment compared to the median industry investment, and Minton and Schrand (1999) report that cash flow volatility is negatively associated with investments in fixed assets, R&D and advertising.

Therefore, I believe that the research question is interesting and relevant. In fact, as MSW point out (in their Section 2.1), there are additional explanations for a relation between cash flow volatility and future cash flows, which make the research question even more appealing. However, by focusing on the underinvestment effect, MSW provide only limited evidence on the research question. In particular, while their results suggest that cash flow volatility helps predict future cash flows, the evidence that the relation is due underinvestment is weak.

My discussion is organized as follows: Section 1 reviews alternative explanations for a relation between cash flow volatility and future cash flows, and how they may affect the interpretation of MSWs results (in particular, the conclusion that the predictive ability of cash flow volatility is due to underinvestment). Section 2 discusses additional concerns regarding the analysis in MSW, and Section 3 presents an empirical analysis that demonstrates some of the arguments in the prior sections. Section 4 concludes.

1. Alternative Explanations for a Relation between Cash Flow Volatility and Future Cash Flows

In their Section 2.1, MSW review alternative explanations (in addition to the underinvestment effect) for a relation between volatility and future cash flows. However, their review is not complete. In addition, some of the alternative explanations have direct implications for the interpretation of MSWs results, and they raise interesting questions for future research. I therefore provide my own review.

Managerial Compensation. To align incentives, provisions of managerial compensation contracts frequently make the manager's total compensation an increasing function of the firm's earnings. Therefore, earnings variability reduces the expected utility of risk-averse managers, which in turn require additional compensation for bearing this risk (see, e.g., Smith and Stulz, 1985).

Taxes. For most firms, the present value of income taxes is convex in taxable income due to (1) progressive tax schedules, (2) delays in obtaining the benefits from tax losses due to carry forwards, and (3) expirations of unexploited tax losses (see, e.g., Graham and Smith, 1999). Consequently, the present value of income taxes increases in the volatility of taxable income. That is, all else equal, higher cash flow volatility implies lower future after-tax cash flows.

Costs of Financial Distress. If customers, suppliers or employees perceive cash flow volatility or factors that are correlated with cash flow volatility to be indicators of financial distress, they may be willing to do business with high cash flow volatility firms only under less favorable terms (see, e.g., Smith and Stulz, 1985). As a result, revenues could be lower and expenses (e.g., cost of goods sold, wages, interest) could be higher for such firms.

Cost of Accessing External Capital. The implicit assumption in the underinvestment story is that firms with sufficient internal funds use the "correct" risk-adjusted discount rate in making investment decisions (i.e., the discount rate appropriate for the risk of the cash flows from the project, independent of the financing). But firms with insufficient funds use higher hurdle rates that reflect the additional cost of accessing external capital due to market imperfections (e.g., asymmetric information). The underinvestment explanation does not require that the effect of market imperfections on the cost of external capital be an increasing function of cash flow volatility. If cash flow volatility is positively related to the cost of accessing external capital (see, e.g., Minton and Schrand, 1999), higher cash flow volatility would imply higher likelihood of forgoing good projects even in periods with "normal" cash flow realizations. That is, this cost of capital effect is incremental to the underinvestment effect, which only emphasizes the likelihood of having substantially smaller than expected cash flows in some periods. (The two effects are not independent; higher cost of accessing external capital exacerbates the underinvestment effect.)

Information Effects. Managers may smooth earnings or cash flows in anticipation of future earnings or cash flows (see, e.g., Ronen and Sadan, 1981; and DeFond and Park, 1997). As a result, earnings volatility or cash flow volatility may provide information about management's expectations of future cash flows.

Real Options. To the extent that managers have the option to modify or abandon loss-generating projects or divisions, negative cash flows are likely to be less permanent than positive cash flows (see, e.g., Berger, Ofek and Swary, 1996). Consequently, holding constant the expected level of cash flows from existing projects or divisions, cash flow volatility should be *positively* related to future cash flows.

Growth. Volatility may be measured unconditionally or conditionally. In measuring unconditional volatility, one subtracts the same expected value from each observation. In contrast, when measuring conditional volatility, one incorporates information about the expected value of each individual observation. I show below that, since growth increases the deviations of cash flows from their unconditional mean, measures of unconditional volatility proxy for growth in addition to conditional volatility. MSW use a measure of unconditional volatility (a variant of the coefficient of variation; more about this below), and hence their analysis and results are likely to reflect the correlation between cash flow volatility and growth in addition to the underinvestment effect.

To demonstrate the relation between unconditional volatility and growth, note that for the time series $X_1, X_2, \ldots, X_T$, the unconditional variance is $E[(X_t - E(\bar{X}))^2]$, while the conditional variance is $E[(X_t - E(X_t))^2]$. So, for example, the trend model (i.e., $X_t = a + bt + \varepsilon_t$) implies that the unconditional variance equals $E[((t - (T+1)/2)b + \varepsilon_t)^2]$, while the conditional variance equals $E[\varepsilon_t^2]$. That is, the unconditional variance increases in the absolute value of b and so it proxies for the extent of growth (or decline) in X.

While I used the trend model to demonstrate the positive relation between unconditional volatility and growth, the same qualitative effect exists for all time-series processes with systematic growth. The solution seems simple: one should measure cash flow volatility using de-trended cash flows (i.e., the residuals from the trend model). Unfortunately, growth in cash flows or earnings is not likely to be linear as assumed by the trend model, and the innovations (i.e., $\varepsilon_1, \varepsilon_2, \ldots, \varepsilon_T$) are not likely to be white noise. Moreover, it is unlikely that any time-series model would allow one to completely remove the effect of systematic growth from actual cash flow or earnings series, so all volatility measures are likely to proxy for growth, at least to some extent. Consequently, cash flow volatility is likely to help predict future cash flows even in the absence of underinvestment (the sign depends on whether cash flows are growing or declining).

Persistence. Cash flow volatility may also proxy for the persistence of cash flows. For the same level of conditional volatility, unconditional volatility increases in the persistence. For example, if cash flows follow an AR(1) model (i.e., $X_t = a + bX_{t-1} + \varepsilon_t$, where b is the persistence parameter and ε_t is white noise), the unconditional variance equals $\frac{1}{1-b^2}$ var(ε_t), while the conditional variance equals var(ε_t). Thus, unconditional cash flow volatility may help forecast cash flows by proxying for their persistence.

The empirical relation between estimates of cash flow volatility and persistence may still be negative rather than positive for two reasons. First, the above illustration assumes that conditional volatility is independent of the persistence parameter. If conditional volatility is negatively related to persistence, the relationship between unconditional volatility and persistence depends on the relative strength of the two effects. Second, persistence induces a negative bias in estimates of cash flow volatility, especially for small sample estimates. I next explain the second effect.

When estimating the variance of a variable, one deducts an estimate for the expected value of the variable from each observation, squares the differences, sums them, and divides the sum by the number of observations *minus one*. The "minus one" is to correct for the fact that the same observations are used in estimating the expected value. As a result, the estimated expected value is on average closer to the observations than the true expected value. When the observations are uncorrelated, "minus one" turns out to provide the required correction to yield an unbiased estimate for the variance. However, when the observations are positively auto-correlated, the "minus one" correction is insufficient, and when the observations are negatively auto-correlated, "minus one" overcorrects for the bias. Consequently, the bias in the estimated volatility is negatively related to persistence. Since the probability limit of the mean is equal to the expected value, the probability limit of the bias is zero. But when using small samples in estimating the volatility (as is the case here), the bias could be severe.

The first five effects discussed above (managerial compensation, taxes, financial distress, cost of accessing external capital, and information) imply that cash flow volatility should be negatively related to future cash flows, as does the underinvestment effect. However, the real options and growth effects imply a positive relation, and the net effect of persistence is unclear. Thus, the relation between cash flow volatility and future cash flows is an empirical question.[2]

2. Concerns Regarding the Analysis in MSW

In this section I discuss additional concerns (besides the exclusion of effects other than underinvestment) that affect the interpretation of MSWs results.

Non-Linearity of the Relation between Future Cash Flows and Current Cash Flow. MSW base their inference on (1) the significance of cash flow volatility in explaining future cash flows, and (2) the improvement in accuracy and bias of forecasts of future cash flows obtained by including cash flow volatility in the forecasting model. However, these results could be due in part to the non-linearity of future cash flows in current cash flow. Cash flow volatility may reduce the effects of non-linearity (bias and inaccuracy) by proxying for a non-linear transformation of current cash flow (indeed, cash flow volatility is measured using the squared cash flows). Cash flow in period $t + 1$ may be non-linear in cash flow in period t because, for example, large cash flows are less permanent than normal cash flows. Fitting a linear model to a non-linear relationship could generate out-of-sample residuals that are non-zero in expectations if the distribution of out-of-sample values for the explanatory variable is different from the distribution of values used in estimating the parameters.[3]

Non-Linearity of the Relation between Future Cash Flows and Volatility. To examine the information in cash flow volatility about future cash flows, MSW focus on models that include volatility as an additive explanatory variable. However, at least some of the effects of cash flow volatility on future cash flows are likely to depend on the current level of cash flows. For example, for a given level of volatility, the costs of financial distress are likely to be negatively related to the level of cash flows (firms with strong cash flows are not likely to incur substantial financial distress costs even if the cash flow is volatile). A similar argument applies to the tax explanation, and, in fact, also to the underinvestment story. Thus, incorporating volatility in a non-linear way may improve its forecasting ability for future cash flows, and it may also result in a more robust test of the explanation/s generating the relation between cash flow volatility and future cash flows.

Seasonality. MSW use quarterly data, so their measure of cash flow volatility increases in seasonality. Seasonality, in turn, may proxy for firm characteristics that are relevant for the prediction of future cash flows, but are not necessarily related to the availability of internal cash flows for investment. This concern is not likely to be negligible. For example, the seasonal cycle in the U.S. accounts for more than 85% of the total fluctuation in the growth rate of real output (Abel and Bernanke, 1998). MSW dismiss this issue by noting that "Minton and Schrand (1999) document that the negative relation between cash flow volatility and investment is not dependent on whether cash flows are seasonally-adjusted prior to measuring the coefficient of variation." I am not sure this evidence generalizes to the MSW tests. The seasonality concern can be addressed by using either seasonally adjusted cash flows or annual cash flows in measuring the volatility.

Available Cash versus Cash Flows. MSW use cash flow volatility as a proxy for the likelihood of having insufficient internal cash flows for investment in profitable projects. However, the likelihood of having insufficient funds for investment is related to the level of cash at the beginning of the period in addition to the cash flow during the period. If the level of cash at the beginning of the period is negatively related to cash flows during the period, it is not clear that low cash flow realizations (and hence cash flow volatility) imply a higher likelihood of having insufficient cash for investment. For example, a seasonal firm is likely to have high levels of cash at the beginning of quarters that provide relatively low cash flows (due to the high cash flows in the previous quarters) and low levels of cash at the beginning of high cash flow quarters (due to the low cash flows in the previous quarters). In addition to seasonality, a negative correlation between cash flow and beginning of period cash could be due to business cycles, life cycles, and operating cycles (see, e.g., Dechow, Kothari and Watts, 1998).

Volatility Measure. MSW measure volatility as the standard deviation of cash flow divided by the mean of the *absolute value* of cash flow. This measure is problematic since the denominator increases in cash flow volatility, offsetting the numerator effect. To see this, note that $E[\text{abs}(X)] = \Pr[X > 0]E[X \mid X > 0] + \Pr[X < 0]E[\text{abs}(X) \mid X < 0]$. For a given $E[X]$, higher volatility implies a "flatter" distribution, which in turn implies higher values for both $E[X \mid X > 0]$ and $E[\text{abs}(X) \mid X < 0]$, and therefore higher $E[\text{abs}(X)]$, the denominator of MSWs volatility measure. As a result, the relation between the MSW measure of volatility and actual cash flow volatility is unclear.

Sample. Due to data requirements, the sample in MSW is small (3,501 observations) and covers a relatively short period of time (1983 through 1997). More importantly, as data (in)availability is not random, the sample may not provide a good representation of the "average firm."

3. Empirical Analysis

Given the concerns raised in the previous sections regarding the interpretation of MSWs results, in this section I provide a simple empirical analysis of the relation between cash flow volatility and current and future cash flows. Unlike MSW, I use a large sample of firms and years, I measure volatility using annual data, and I do not deflate the volatility measure by the mean of the absolute value of cash flow. I also do not adjust operating cash flow for R&D or advertising, nor do I include any control variables besides current cash flow. Moreover, rather than incorporating cash flow volatility as an independent variable in explaining future cash flow, I examine how the relation between future and current cash flows depends on cash flow volatility. Specifically, I sort portfolios based on cash flow volatility and regress future cash flow on current cash flow within each portfolio. I then plot the intercept, slope and R^2 from the regressions against the portfolios' rank of cash flow volatility. I also examine the distribution of cash flow volatility and the relationship between the portfolios' rank of cash flow volatility and the current level of cash flow, future short-term growth in cash flow, and future long-term growth.

I focus on current and next year's operating cash flows, and measure cash flow volatility as the standard deviation of annual cash flow from operations over the five years that end in the current year.[4] To control for differences in size, I deflate current and future cash flows as well as cash flow volatility by the average balance of total assets in the current year. To minimize the effect of extreme observations, current and future cash flows are trimmed at the 1th and 99th percentile values. The sample includes all NYSE, AMEX and NASDAQ firm-year observations with available data in COMPUSTAT (90,532 observations during the years 1966 through 1999).

Figure 1 presents the intercept, slope and R^2 from regressions of next year's cash flow from operations on current year cash flow from operations. The 100 observations correspond to portfolios sorted by cash flow volatility. To help identify the shape of the relationship, a moving average trend-line (ten observations) is also plotted.

The results are very interesting. For most firms, the intercept is *positively* related to cash flow volatility, although the relationship is not very strong. The slope, on the other hand, is

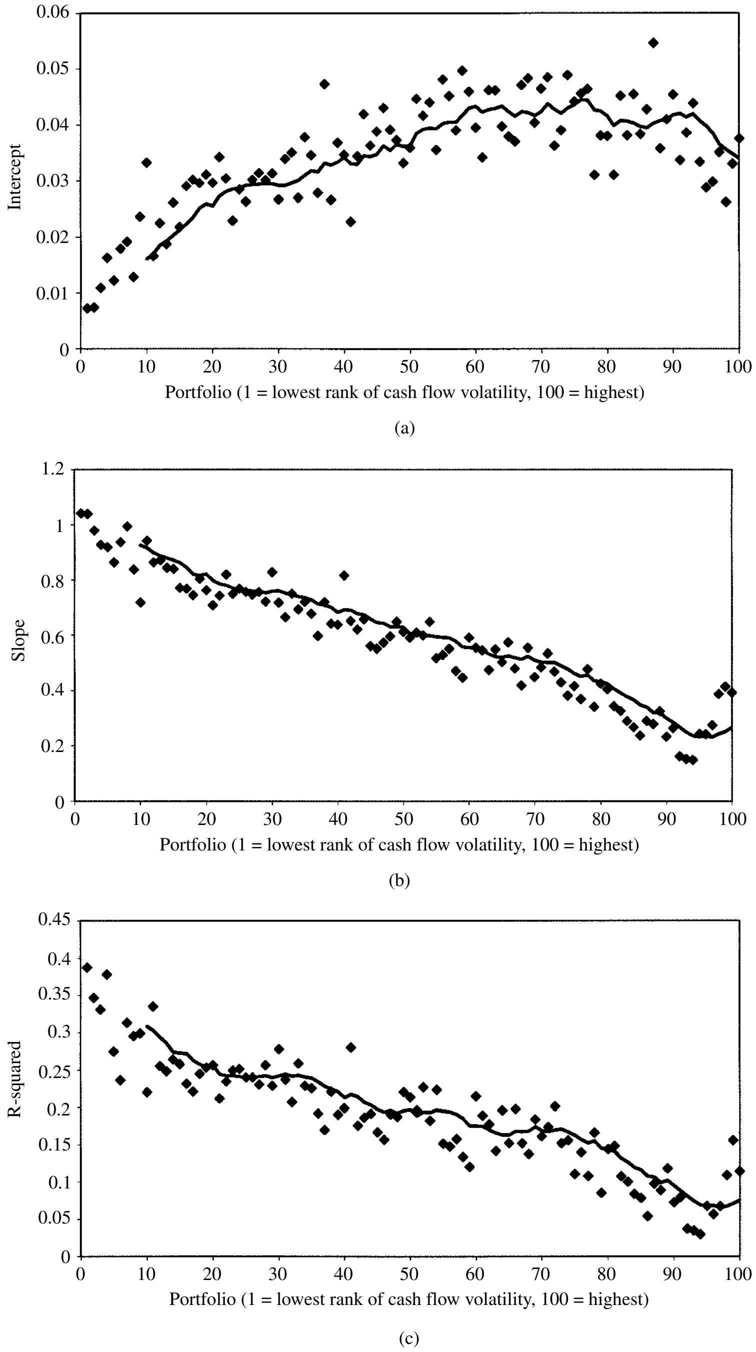

Figure 1. Intercept, slope and R^2 from portfolio regressions of next year's cash flow on current cash flow. Portfolios sorted by cash flow volatility. (a) Intercept, (b) slope, (c) R^2.

negatively and strongly related to cash flow volatility. The pattern of R^2 is similar to that of the slope, although the relationship is not as strong. The intercept pattern is inconsistent with the results in MSW (which essentially find that the intercept is *negatively* related to cash flow volatility), but the difference may be explained by the slope pattern. As the average level of cash flows is positive, the negative correlation between the slope and cash flow volatility induces a negative correlation between the intercept and cash flow volatility when the slope is omitted (MSW do not allow the slope to depend on cash flow volatility). Therefore, the results in Figure 1 suggest that in predicting future cash flows, or in testing explanations for the relationship between cash flow volatility and future cash flows, including cash flow volatility in an additive way is not likely to be sufficient.

Panel (a) of Figure 2 reinforces this point by showing that the distribution of cash flow volatility is highly skewed to the right. As the plots in Figure 1 do not demonstrate similar patterns, the tentative conclusion is that by incorporating cash flow volatility in a non-parametric

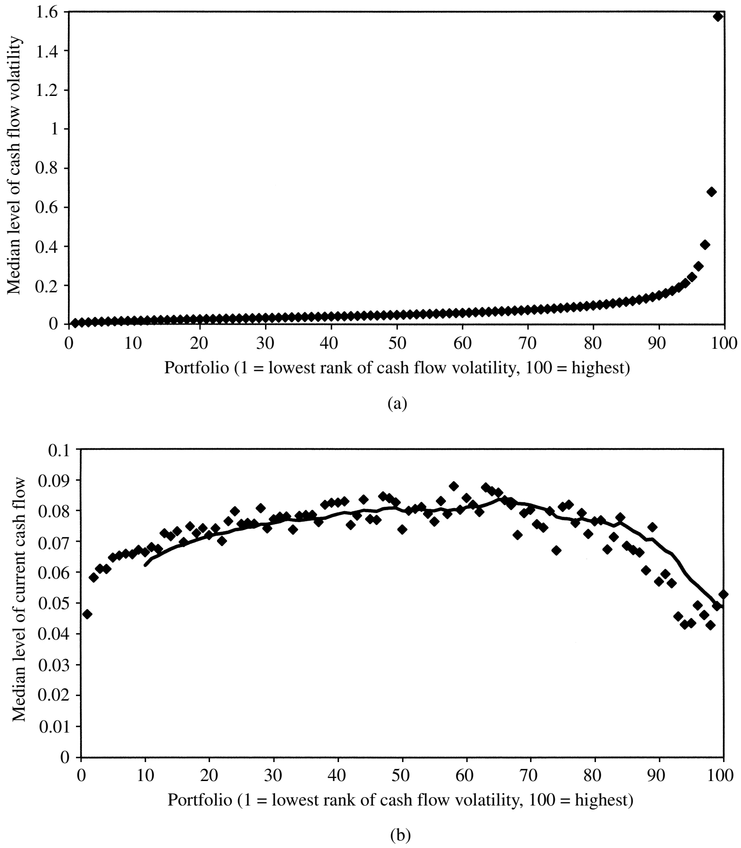

Figure 2. Median portfolio levels of cash flow volatility, current cash flow, short-term growth in cash flow, and long-term growth in cash flow. Portfolios sorted by cash flow volatility. (a) Cash flow volatility (Portfolio 100, the highest cash flow volatility, is deleted. The median level of cash flow volatility for this portfolio is 8.07.) (b) current level of cash flows, (c) short-term growth in cash flows, (d) long-term growth in cash flows.

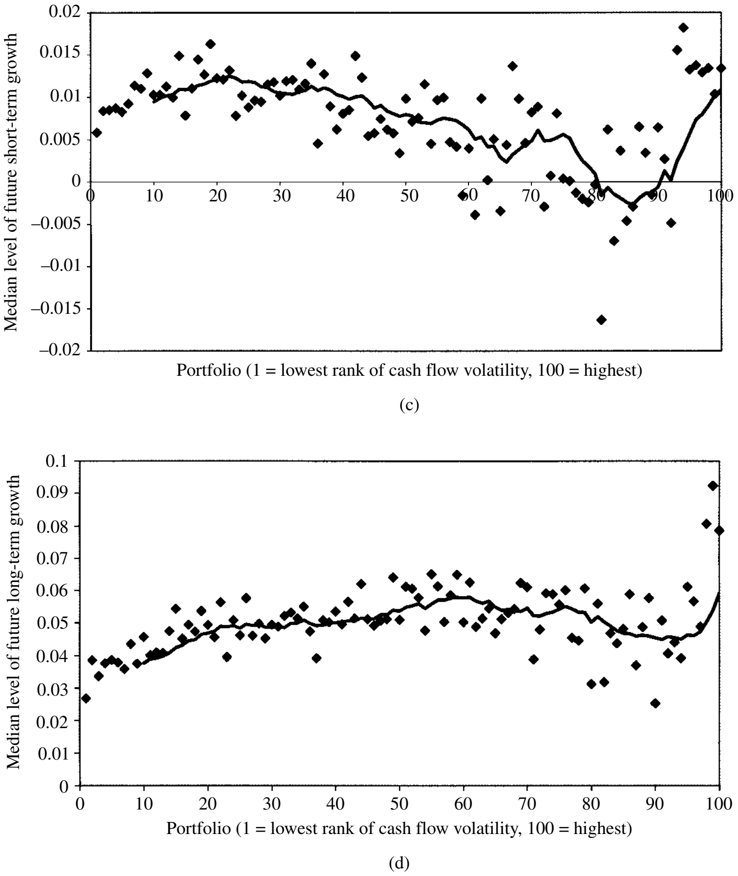

Figure 2. (*Continued*)

way or by applying a transformation that reduces the skewness of cash flow volatility, one is likely to improve the forecasting ability of cash flow volatility for future cash flows.[5]

Figure 2 also plots the median portfolio levels of current cash flow from operations, and short- and long-term growth in cash flow. Short-term growth in cash flow is measured as the median change in operating cash flow from the current to next year, while long-term growth is measured as the median change from the current to five years ahead cash flow. As before, all variables are deflated by the average balance of total assets in the current year. Inconsistent with the (conditional) implication of the underinvestment story, for most firms volatility is *positively* related to the current level of cash flow. However, firms with very high volatility have the lowest cash flows. For most firms, there appears to be a negative relation between volatility and short-term growth, but a positive relation between volatility and long-term growth. One may speculate about possible explanations for these patterns, but without a comprehensive analysis that incorporates proxies for all the effects described in Section 1, it would be difficult to make a sound inference. Nevertheless, these results suggest that the information in volatility about future cash flows is not likely to be limited to the underinvestment effect, and that underinvestment may be a relatively unimportant factor in explaining the relationship.

4. Conclusion

MSW address an interesting and relevant issue on which there is little direct evidence—the relation between cash flow volatility and future cash flows. They provide evidence that supports the existence of a relationship, and suggests investors do not completely understand it. However, their analysis does not convincingly identify the explanation/s for the relationship, primarily because they do not consider alternative explanations besides underinvestment. In addition, there are several ways in which the forecasting ability of volatility may be improved, including allowing for non-linearity, using alternative measures of volatility, and examining larger and more representative samples. Future research may also use current price (in addition to future cash flows and stock returns that MSW examine) to gauge the information in cash flow volatility. An especially interesting study would be one that disentangles the "numerator" (i.e., expected future cash flows) and "denominator" (i.e., the discount rate) effects of cash flow volatility.

Notes

1. In a recent paper, Gebhardt, Lee and Swaminathan (2001) demonstrate that earnings volatility is also related to ex-ante measures of the cost of capital.
2. Note that some of the effects represent association and not causation (e.g., growth and persistence). But association that is not fully accounted for by including the causes (which in most cases are unobservable) is also relevant for prediction purposes.
3. Another possible explanation for consistently observing significant out-of-sample average residuals (i.e., "bias") is that the out-of-sample distribution of omitted variables is different from their in-sample distribution (which affects the values of the dependent variable used in estimating the model).
4. Cash from operations is estimated as earnings minus total accruals. Total accruals (TA) are estimated as follows: $TA = \Delta CA - \Delta CL - \Delta Cash + \Delta STD - Dep$, where ΔCA equals the change in current assets (COMPUSTAT item 4), ΔCL equals the change in current liabilities (COMPUSTAT item 5), $\Delta Cash$ equals the change in cash and cash equivalents (COMPUSTAT item 1), ΔSTD equals the change in debt included in current liabilities (COMPUSTAT item 34), and Dep equals depreciation and amortization expense (COMPUSTAT item 14). Earnings are measured as net income before extraordinary items and discontinued operations (COMPUSTAT item 18).
5. Note that deleting "outliers" is not likely to be sufficient, since the positive skewness is due to the highest ten percent of the observations and not to a few extreme observations.

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