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Private Equity and the Leverage Myth

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Abstract

Investors have traditionally relied on mean-variance analysis to determine a portfolio's optimal asset mix, but they have struggled to incorporate private equity into this framework because they do not know how to estimate its risk. The observed volatility of private equity returns is unrealistically low because the recorded returns of private equity are based on appraised values, which are serially linked to each other. These linked appraisals, therefore, significantly dampen the observed volatility. As an alternative to observed volatility some investors have argued that private equity volatility should be estimated as leveraged public equity volatility, because private equity companies are more highly levered than publicly traded companies. However, this approach yields unrealistically high values for private equity volatility, which invites the following question. Why isn't the appropriately leveraged volatility of public companies a reasonable approximation of private equity volatility? This paper offers an answer to this puzzle.

PRIVATE EQUITY AND THE LEVERAGE MYTH[1]

INTRODUCTION

Investors struggle to incorporate private equity into mean-variance analysis because they do not know how to measure its volatility. They recognize that the observed volatility of private equity returns is unrealistically low because returns are estimated from appraised values which are serially dependent.[2] This serial dependence arises because appraisals rely, in whole or in part, on stale information from events that occurred prior to the valuation date. For example, appraisers may reflect the values of comparable privately held companies that were bought or sold in the past. Or, they may anchor company valuations to their own prior values. Because each period's appraisal incorporates values from prior periods, the returns of an appraisal-based index are artificially smooth, akin to a moving average.

Some have suggested that private equity volatility should be estimated as leveraged public equity volatility, because private equity firms are more highly levered than public firms.[3] But this approach produces unrealistically high values, which is puzzling. Why isn't the relative volatility of private equity related to its relative leverage? Because the public market is considerably less opaque than the private market, we approach this question by looking for clues from the public equity market.

To begin, we show how leverage should affect volatility theoretically. We then document the extent to which private equity violates this theoretical relationship. We also simulate the effect of leverage on volatility, which underscores the disconnect between leverage and private equity volatility. We then turn to the public market in search of clues about the relationship between leverage and volatility. We first sort public firms by their explicit leverage and compare these differences to differences in volatility. We then regress volatility on leverage both across time and cross sectionally, controlling for a wide range of confounding factors. These regressions fail to show a relationship between leverage and volatility. Then we examine several individual companies anecdotally to gain a better understanding of the apparent disassociation between leverage and volatility.   By induction we extend our findings to private equity and propose an approach for measuring private equity volatility, which, in our view, yields realistic values.

LITERATURE REVIEW

It is common practice for investors to estimate the volatility of private equity buyouts by applying a leverage multiple to public equity volatility. This approach is also espoused widely in the literature:

- L'Her et al (2016) estimate the net debt-to-enterprise value ratio for buyouts to be 55 percent on average versus 25 to 30 percent for public companies. They extrapolate this finding to recommend that public market returns be scaled up to adjust for this leverage differential to compare with buyout performance.

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- Stafford (2015) notes that a typical private equity transaction increases debt-to-enterprise value from roughly 30 to 70 percent, and that an investor in public markets would therefore need to invest about double the capital to generate returns similar to those of private buyouts.

- Chingono and Rasmussen (2015) equate private equity buyouts to investments in levered (public) small cap value companies.

- L'Her et al (2017) state that "1.2 should be viewed as a minimum beta estimate for buyout funds," which they attribute to the observation that buyouts have significantly higher leverage multiples than public firms. Axelson et al (2014) and Harris et al (2016) make similar assertions with leverage-adjusted beta estimates for buyouts ranging between 1.5 and 2.7.

THE PRIVATE EQUITY LEVERAGE PUZZLE

Private equity firms are highly levered, yet their observed volatility is lower than that of public equity. Even after adjusting for the smoothing effect introduced by appraisals, private equity volatility is significantly lower than the product of public equity volatility and the relative leverage of private equity to public equity.

In principle, equity volatility should scale directly with leverage absent other effects, as shown in Equation 1.

$$\sigma_E = L\sigma_A \qquad\qquad (1)$$

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In equation 1, σ_E equals equity volatility, L equals leverage (assets / equity), and σ_A equals asset volatility.

Axelson et al (2013) show that buyout firms have approximately two times more leverage than their public counterparts. Therefore, based on Equation 1 above and assuming similar asset volatility between the two groups, we would expect buyout equity's volatility to be roughly two times that of public equity's volatility. This is not what we observe empirically.

Exhibit 1 compares public and private equity volatility over the period December 1996 through September 2018. We use the S&P 500 Index to represent public equity and the buyout segment of the State Street Private Equity Index to represent private equity.[4] We measure the volatility of quarterly total returns for the S&P 500 and quarterly IRRs for private equity. To account for the smoothing effect appraisals have on private equity valuations, we also measure the volatility of overlapping annual and triennial returns.[5] The first column reports public equity's volatility, the second set of columns shows the expected volatility of private equity assuming it is twice that of public equity (given that it has two times more leverage), and the third set of columns reports private equity's actual volatility.

Exhibit 1: Expected and Actual Volatility (December 1996 - September 2018, Annualized)

	Public equity	Expected		Actual	
		Private equity	Ratio	Private equity	Ratio
Quarterly	16.3%	32.6%	2.00	9.9%	0.61
Annual	17.8%	35.5%	2.00	15.4%	0.87
Triennial	17.6%	35.2%	2.00	17.0%	0.97

Contrary to the expectation that leverage should have a one-to-one relationship with volatility, Exhibit 1 shows that leverage has no apparent effect on private equity volatility. Actual private equity volatility does increase over longer measurement intervals, which is a function of its serial dependence. But it falls short of public equity volatility when we would expect it to be twice as large. Therein lies the puzzle.

SIMULATED EFFECT OF LEVERAGE ON VOLATILITY

To support the validity of our expectation from Equation 1 of a one-to-one relationship between leverage and volatility we simulate the theoretical association of leverage and volatility using the following steps.

1. We form 500 hypothetical new "companies" that each consist of investment in one of the S&P 500 stocks as the sole "asset."

2. Each year we introduce random amounts of leverage (measured as the asset-to-equity ratio), modeled from a distribution with a mean of 1.5 and a lower bound of 1, to each hypothetical company and record the monthly returns of these levered companies over time.[6] Thus, we have added leverage mechanically to each position in a way that is uncorrelated to all other variables.

3. We record the annual volatility of each new company.

4. We repeat steps 2-3 to generate results for a 28-year period.

5. We run panel time series and cross-sectional regressions (specified later).

The results of this experiment are shown in Exhibit 2.

Exhibit 2A: Time series panel regression of firm volatility on leverage and market volatility

	Beta	T-Statistic	R-Squared
Leverage	1.01	95.45	0.63
Market volatility	0.45	5.19	

Exhibit 2B: Cross-sectional panel regression of firm volatility on leverage

	Beta	T-Statistic	R-Squared
Leverage	0.99	45.64	0.43

The leverage coefficient of 1.01 in Exhibit 2A is consistent with a one-to-one relationship between leverage and volatility through time. When a given company's leverage goes up from one year to the next, its volatility increases proportionally. The leverage coefficient of 0.99 in Exhibit 2B reveals the analogous one-to-one relationship in the cross-section of companies. In any given year, the synthetic companies with higher leverage have higher volatility than those with lower leverage.

These simulations lend unambiguous credence to the notion that volatility should scale directly with the degree of leverage. We are therefore left with the puzzle that even though private equity has twice the leverage of public equity, its volatility adjusted for smoothing is no greater than public equity volatility. To resolve this puzzle, we turn to the public market to look for clues about the empirical relationship between leverage and volatility.

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THE EFFECT OF LEVERAGE ON VOLATILITY IN THE PUBLIC EQUITY MARKET

We base our analysis of leverage and volatility within the public equity market on the

constituents of the S&P 500 Index from March 2001 through October 2018. Within groups of

stocks with similar levels of fundamental risk, we form capitalization-weighted portfolios

according to leverage. Specifically, each month we form 16 portfolios by (1) sorting stocks into

quartiles according to their borrowing cost[7] (a proxy for the fundamental risk of their

underlying businesses, irrespective of the degree of leverage) and then (2) within each

fundamental risk quartile, sorting stocks into quartiles according to their leverage (asset to

equity ratio). We record the monthly returns of these 16 portfolios over the full sample.

We next evaluate the impact of leverage while controlling for differences in

fundamental risk across firms. Specifically, within each risk quartile, we compare the volatility

of the portfolio of firms with the highest leverage to the volatility of the portfolio of firms with

the lowest leverage. These ratios are reported in Exhibit 3 (light gray bars). For comparison, we

also show the ratio of leverage for the same portfolios (dark gray bars). For example, on

average, within the universe of firms with the lowest fundamental risk (quartile 1), the most

levered firms have two times more leverage than the least levered firms and the volatility of

their returns is 1.3 times greater.

If leverage functions as expected, the volatility ratios should be of similar magnitude to

the leverage ratios. However, for every quartile of fundamental risk, they are about half of what

we would expect. Moreover, the rightmost bars report results for portfolios that ignore

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fundamental risk (they are single-sort portfolios formed on leverage alone). If borrowing costs effectively proxy for fundamental risk, we would expect a stronger relationship between leverage and volatility for the double-sort portfolios than for the single-sort portfolios. Again, this is not the case.

Exhibit 3: High Leverage Portfolios versus Low Leverage Portfolios

Control Variable: Borrowing Costs
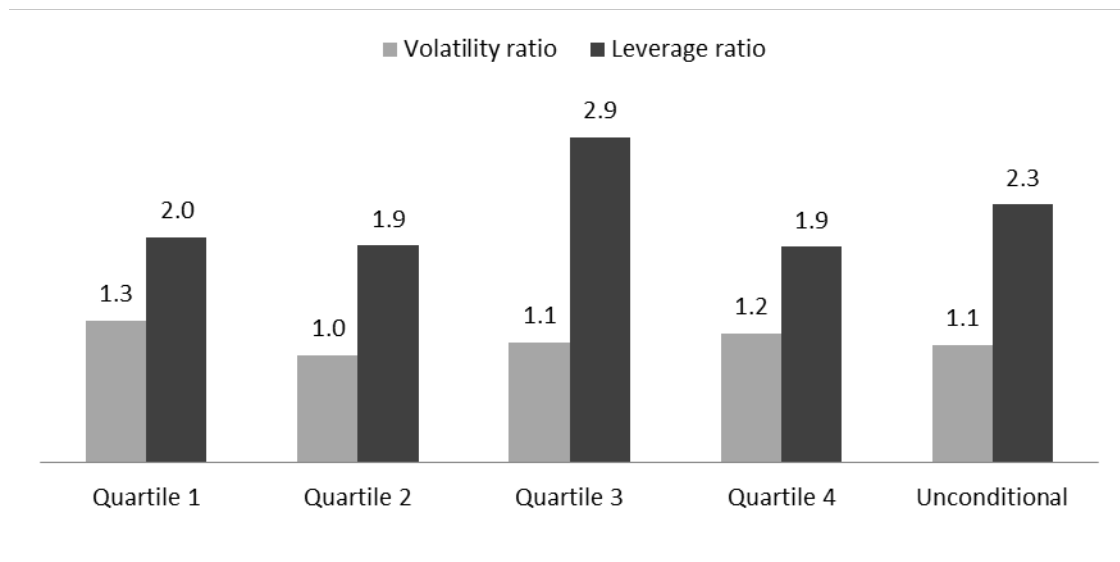
We repeat the experiment using two alternative proxies for fundamental risk: level of cash flows and volatility of cash flows.[8] All else equal, we presume that companies with higher and more stable cash flows relative to their book value are inherently less risky. Exhibit 4 summarizes the average volatility and leverage ratios of the double-sort portfolios. Again we find that the volatility ratio of highly levered firms to firms with low leverage does not come close to matching the ratio of their respective amounts of leverage.

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Exhibit 4: High Leverage Portfolios versus Low Leverage Portfolios

Control Variables: Level and Volatility of Cash Flows
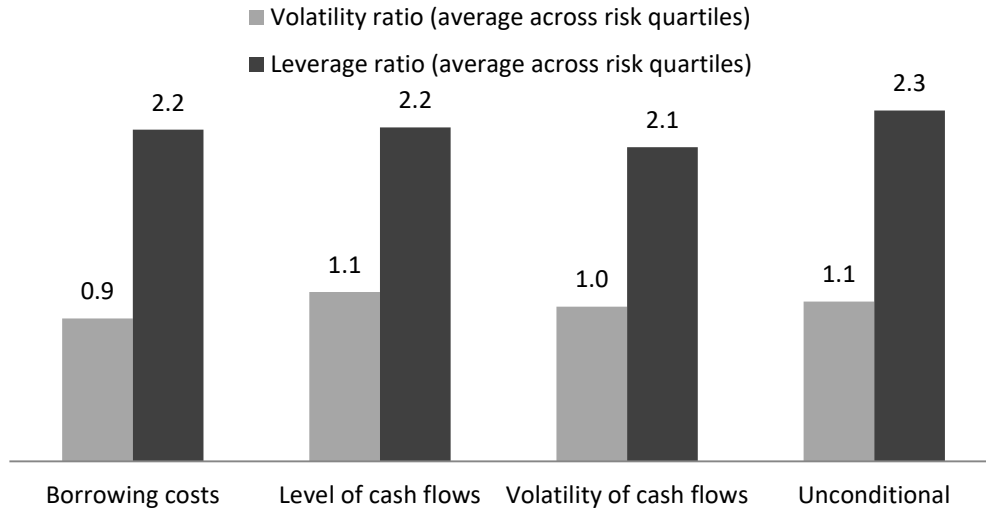
Next we resort to regression analysis to determine if differences in volatility correspond to differences in leverage. Our data comprises the S&P 500 constituents from January 1990 through December 2017. We exclude firms with no leverage as well as annual equity volatilities that reside in the 5% right tail of the distribution. We run two panel regressions: one which captures the time series relationship between equity volatility and leverage and another which captures the cross-sectional relationship. We use the natural log of each variable in order to transform equity volatility into a linear combination of leverage and asset volatility.

For the time-series panel regression, we include a constant for each stock (firm fixed effects) and use market volatility to represent asset volatility, as shown in Equation 2

$$\ln \sigma_{i,t} = \beta_1 \ln L_{i,t-1} + \beta_2 \ln \sigma_{M,t} + \text{firm fixed effects} + u_{n,t} \qquad (2)$$

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In Equation 2, $\sigma_{i,t}$ equals volatility of firm i's equity over calendar year t, $\sigma_{M,t}$ equals volatility of market (S&P 500) over calendar year t, and $L_{i,t-1}$ equals leverage (assets / equity) of firm i at end of year t-1.

For the cross-sectional panel regression, shown in Equation 3, we include a constant for each year (year fixed effects).

$$\ln \sigma_{i,t} = \beta_1 \ln L_{i,t-1} + \text{year fixed effects} + u_{n,t} \qquad (3)$$

In Equation 3, $\sigma_{i,t}$ equals volatility of firm i's equity over calendar year t and $L_{i,t-1}$ equals leverage (assets / equity) of firm i at end of year t-1. In both regressions we adjust the standard errors to account for possible correlations across firms.

Exhibit 5 shows results from the time series panel regression. In addition to the baseline regression described above, we also report leverage coefficients for three variants. First, we control for changes in the average amount of leverage in the market from year to year. Second, we exclude financial and utility companies, recognizing that their capital structure may differ from other sectors. Third, we exclude the global financial crisis period of 2008-2009, recognizing that extraordinary events during this period may distort our results. Yet, in each case we are unable to reject the null hypothesis that the leverage coefficient equals zero.

Exhibit 5: Time Series Panel Regression

	Beta	T-Statistic	R-Squared
Leverage	0.11	1.41	0.50
Market volatility	0.39	5.41	

	Leverage Beta	T-Statistic	R-Squared
Controlling for market leverage	0.08	1.01	0.52
Excluding financial and utility companies	0.10	1.51	0.50
Excluding global financial crisis (2008 and 2009)	0.10	1.42	0.50

Exhibit 6 shows the cross-sectional results. In this case we introduce four variants, each designed to control for the underlying volatility of a company's assets. First, we again exclude financial and utility companies from the analysis, as we did with the time series regression. We also control for the three measures of fundmanetal risk introduced in Exhibit 4.

Exhibit 6: Cross-Sectional Panel Regression

	Beta	T-Statistic	R-Squared
Leverage	-0.03	-1.40	0.25

	Leverage Beta	T-Statistic	R-Squared
Excluding financial and utility companies	-0.03	-1.24	0.24
Controlling for firm-specific borrowing costs	-0.02	-0.93	0.26
Controlling for level of firm-specific cash flows	-0.07	-1.55	0.31
Controlling for volatility of firm-specific cash flows	-0.08	-2.49	0.31

Again, we see no evidence that volatility scales with leverage. The coefficients are not only insignificant; they are in the wrong direction as well. Given this evidence of the lack of association between leverage and volatility in the public equity market, it is unsurprising that private equity volatility shows no correspondence to leverage. In the next section we examine two companies in search of anecdotal evidence to explain the lack of correspondence between leverage and volatility.

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ANECDOTAL EVIDENCE

The following analysis highlights why it is difficult to capture the expected relationship between leverage and volatility.

Exhibits 7 and 8 depict the relationship between leverage and volatility for two companies: Motorola and Clorox. They illustrate that volatility can be highly time-varying even during periods where leverage is relatively stable. These examples reveal why a time series regression cannot detect a relationship. Even surrounding dramatic changes in the leverage of both firms, we do not observe commensurate changes in volatility. In fact, these two companies both increased their leverage following steep *declines* in volatility. The degree of leverage is an endogenous, firm-specific decision; it stands to reason that low-risk companies incur more leverage, all else equal, precisely *because* they are more able to do so.
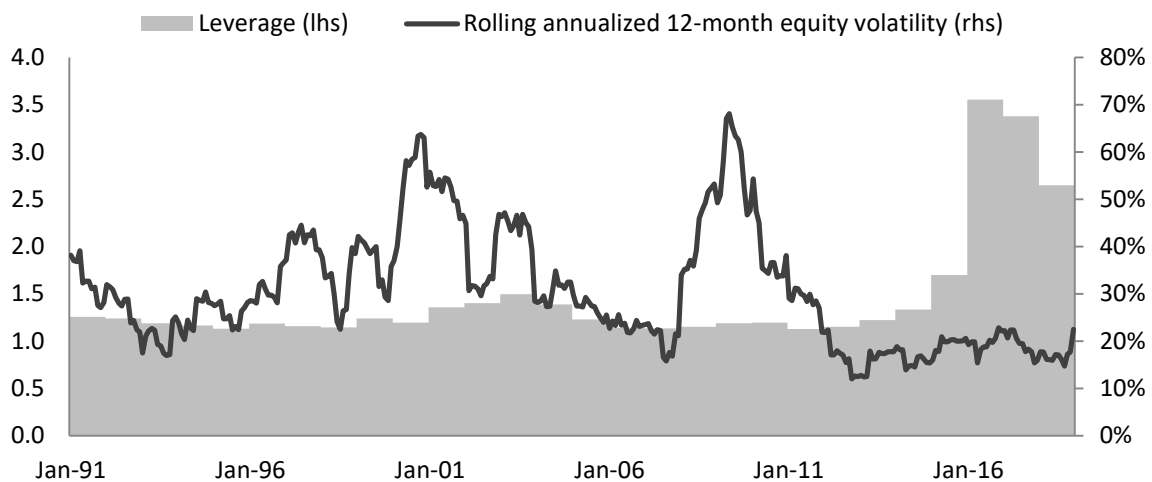
Exhibit 7: Leverage and Volatility (Motorola)

Exhibit 7 plots the relationship between the rolling one-year volatility of Motorola shares against its rolling asset-to-equity ratio. The volatility of Motorola stock varied widely between 1991 and 2013, reaching a high of 70% during the global financial crisis and a low of approximately 20% in recent years. Yet its leverage hardly changed at all during this period. Furthermore, when the company tripled its leverage between 2015 and 2018, there was no apparent impact on its volatility. There does not appear to be any discernible relationship between the leverage and volatility of Clorox, either, as shown in Exhibit 8. For example, the firm has gradually reduced its leverage since 2011 only to see its share price volatility rise.

Exhibit 8: Leverage and Volatility (Clorox)
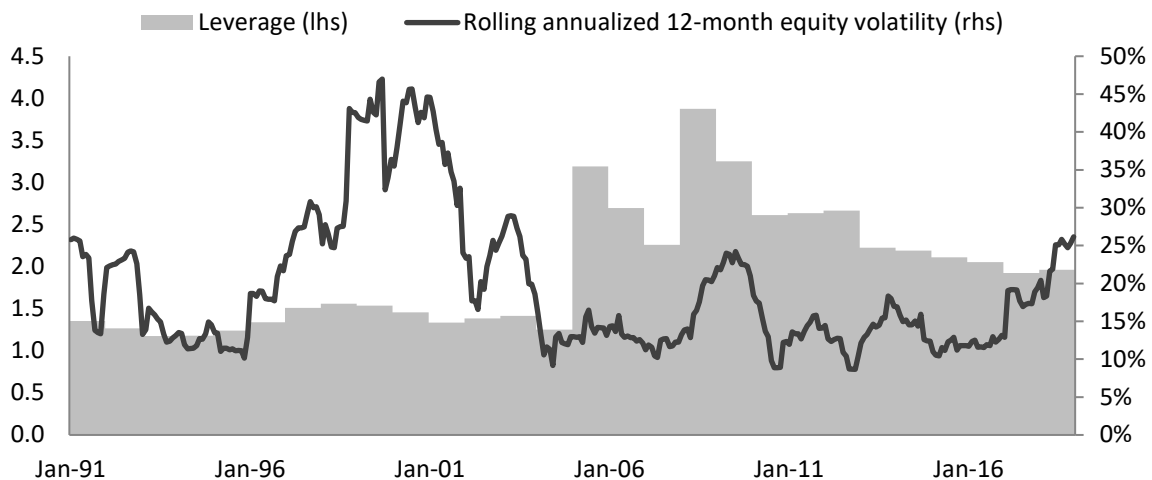
Next, we explore some of the fundamental factors that hide the effect of leverage on volatility. We find that financial leverage is a poor indicator of effective leverage for firms with substantial non-debt obligations. Moreover, we find that fundamental risk is unobservable and

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difficult to proxy. We illustrate these issues in Exhibit 9 by analyzing six companies: Lincoln National, AIG, GM, McDonalds, GE, and Cummins. Our observations are as follows.

- Compared to the other companies, Lincoln National and AIG have relatively low leverage but high volatility. This is because they carry a lot of non-debt liabilities in the form of insurance reserves.

- Within the consumer discretionary sector, GM has lower leverage than McDonalds but higher volatility. This may reflect the substantial size of its pension fund.

- Within the industrial sector, GE has higher leverage than Cummins but lower volatility. It could be the case that GE is fundamentally safer. It has significantly lower borrowing costs; however, its profitability measures are similar to Cummins profitability measures.

Exhibit 9 highlights but a few of the countless factors that can affect a firm's inherent risk and thereby complicate the relationship between its leverage and volatility. We submit that this complexity renders it difficult, if not impossible, to control systematically for these factors in public markets let alone in private markets where the required data is scarce.

	Financials		Industrials		Consumer discretionary	
	Lincoln National	AIG	Cummins	GE	General Motors[8]	McDonalds
Leverage	1.02	1.17	1.21	2.11	1.49	2.01
Volatility	38%	65%	36%	25%	27%	21%
Fundamental risk						
Credit worthiness						
Borrowing costs[1]	7.1%	6.1%	7.0%	4.3%	7.2%	5.4%
Profitability						
Level of cash flows[2]	26%	14%	32%	33%	39%	25%
Volatility of cash flows[3]	15%	67%	17%	13%	8%	65%
Dividend yield	2.9%	0.6%	2.2%	2.9%	2.5%	1.9%
Other obligations						
Non-debt liabilities						
Deferred income + reserves[4]	40%	52%	1%	0%	1%	0%
Pension obligations[5]						
Plan size[6]	0.01	0.01	0.33	0.09	0.59	n/a
Funding status[7]	89%	73%	91%	82%	80%	n/a

[1] Estimated as interest expense / (ST debt + current LT debt + LT debt)
[2] Measured as cash flow from operations normalized by book value of assets
[3] Volatility of normalized cash flows (note 2)
[4] Measured as (insurance reserves + deferred income) / book value of assets
[5] Pension obligation data begins in 2002
[6] Measured as fair value of plan assets divided by book value of assets
[7] Measured as fair value of plan assets divided by projected benefit obligation
[8] General Motors' (GM) data begins in 2009. If we measure McDonalds' leverage and volatility for the overlapping sample, the comparison is even starker: McDonalds' leverage is 3.33 (compared to GM's 1.49) and its volatility is 13% (compared to GM's 27%).

SUMMARY

The observed volatility of private equity is unrealistically low compared to the volatility of public equity. Investors have recognized that this apparent low volatility arises from the fact that valuations are based on appraisals which are anchored to prior period valuations. This practice has the effect of smoothing returns. Investors can offset this effect by estimating volatility from rolling longer-interval returns such as annual or triennial returns. With this

adjustment private equity volatility is similar to public equity volatility. Of course, it will differ by sub-categories within private equity.

Be that as it may, many investors believe that private equity volatility should be much higher than public equity volatility because private equity is much more highly levered than public equity. We showed both theoretically and by simulation that volatility should scale directly with leverage. However, it turns out that private equity volatility, adjusted for smoothing, is approximately equal to public equity volatility despite its much greater leverage, which presents a puzzle. To address this puzzle, we resorted to analyzing the relationship between leverage and volatility in the public market, where data is easier to come by. Using sorts as well as time series and cross sectional regressions we were unable to detect any relationship between leverage and volatility that conforms even remotely to the theoretical relationship of leverage and volatility. To put it bluntly, our results were robustly insignificant.

Next we sought to understand why we could not uncover a statistical relationship between leverage and private equity. First we reviewed the time series properties of leverage and volatility for two companies. We discovered that leverage is often stable for long periods whereas volatility is highly time varying. This is the proximate cause of why we cannot detect a time series relationship.

We next reviewed the financial conditions of several companies. This analysis revealed that companies have several sources of implicit leverage which obscures the effect of explicit leverage. We also observed that asset stability differs significantly across companies for a variety of business reasons which confounds the effect of explicit leverage on volatility.   This

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anecdotal evidence suggests to us that the relationship of leverage and volatility is hopelessly obscured by a variety of confounding effects.

We assert that the volatility we estimate from longer-interval private equity returns (to offset the effect of valuation smoothing) is the correct approximation of private equity volatility because it approximates the actual distribution of outcomes realized by private equity investors over longer horizons. When applied to the data, this approach yields the stubborn conclusion that private equity volatility is similar to public equity volatility despite its higher leverage. Why is this the case? It could be that buyout fund managers prefer to invest in companies whose underlying business activities are inherently less risky and can therefore bear higher leverage, which increases profits. Whatever the reason, our findings debunk the widespread misconception that private equity has higher volatility than public equity volatility as a result of its higher leverage.

NOTES

The material presented is for informational purposes only. The views expressed in the material are the views of the authors and are subject to change based on market and other conditions and factors; moreover, they do not necessarily represent the official views of Windham Capital Management, State Street Global Markets or State Street Corporation and its affiliates.

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[1] We thank our colleagues Nan R. Zhang and Yaoyun Zhang for helpful comments and discussion on this topic.
[2] The observed volatility of private equity is also understated because it is based on returns net of performance fees which attenuate upside deviations but downside deviations. Because standard deviation does not distinguish between upside and downside deviations, performance fees reduce standard deviation but not downside risk,

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which is what matters. In our analysis, we ignore this effect because it is not that large; we have found in previous research that it misstates standard deviation by about 1%.

[3] Not all privately equity investments are levered. In this paper, we focus on buyout funds because they represent the largest segment of the private equity market overall and are of the greatest interest to large, institutional investors. Buyout investors employ more leverage, on average, than public companies.

[4] The State Street Private Equity Index captures the pooled Internal Rate of Return (IRR) each quarter for 3,097 private equity funds in which State Street clients are limited partners. The IRR calculation incorporates quarterly NAVs for each fund as well as daily net cash flows that occurred throughout the quarter. The index captures a total commitment size of $3.1 trillion as of September 30, 2019.

[5] An alternate approach is to estimate the serial correlation statistics of the return series with a regression and reverse engineer the estimated smoothing effects. The approach is often called de-smoothing. Measuring volatility from longer interval returns has the same effect because multi-period returns contain all of the effects of serial correlation. Longer interval returns have the advantage that they represent an actual investment outcome and they do not require a model to estimate.

[6] We draw from a log-normal distribution with a mean of 0.50 (representing the debt-to-equity ratio) and which has a lower bound of zero. Then we add one to the simulated values to put them in units of assets-to-equity.

[7] We proxy borrowing costs with Worldscope item 08356, "Interest Rate- Estimated Average," which is computed as interest expense divided by the sum of short-term debt, current long-term debt, and long-term debt. We exclude observations with zero borrowing costs, negative borrowing costs, and those that reside in the 5% right tail of the distribution. All data is from the Worldscope database obtained via Datastream.

[8] We compute the level of cash flows as cash flow from operations (Worldscope item 18310A) divided by the book value of assets (Worldscope item 03501A). We compute the volatility of cash flows as the rolling 5-year volatility of the level. For both variables, we exclude observations that reside in the 5% right tail of their respective distribution. All data is from the Worldscope database obtained via Datastream.

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