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# Dealing with non-normality when estimating abnormal returns and systematic risk of private equity: A closed-form solution ☆

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ABSTRACT

The paper develops a novel econometric approach to estimate abnormal returns and systematic risk of private equity from observable investment cash flows. The unique features of the method are that it provides closed-form estimators and that it employs a generalized CAPM, which accurately takes into account that private equity returns typically deviate from a normal distribution. The methodology is validated using numerical examples and is applied to a comprehensive sample of 12,565 portfolio company investments by private equity funds. The results highlight that ignoring coskewness of private equity returns can result in biased estimates of abnormal returns and systematic risk.



Since inception in the early 1980s, institutionalized private equity has grown to a multitrillion dollar asset class spanning globally. Institutional investors such as pension funds and endowments commit up to 20% of their capital to private equity funds. Investments by financial sponsors account for up to 40% of M&A activity in the U.S.[1] Despite three decades of operations and a material economic impact, evaluating the systematic risk and abnormal returns of private equity funds and their underlying portfolio company investments is difficult. Beside the general challenge of obtaining large scale sample data on private equity, the main reason is the illiquid nature of the asset class – neither the interests in a private equity fund, nor its portfolio companies are typically traded. Thus, one can only observe a stream of investment cash flows but no market valuations. Absent regular valuations in an efficient market, however, the application of standard econometric approaches is infeasible.

The paper develops a novel econometric approach to estimate abnormal returns and systematic risk of private equity investments from a cross-section of observable investment cash flows. A key feature of the methods is that it allows deriving

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[1] Estimations based on data from Preqin (on fundraising and asset allocation) and Thomson (on M&A activity).

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closed-form estimators for systematic risk and abnormal returns, while previous research in this area (e.g. Driessen et al. (2012) and Ang et al. (2013)) has to resort to difficult to implement numerical techniques to estimate parameters. In addition, the estimators in this paper are derived using the Rubinstein (1976) model and the associated generalized CAPM developed in Leland (1999). For brevity this will be referred to in the remainder of this paper as the Rubinstein–Leland CAPM. Previous research derives estimates that are based on the standard CAPM. The drawback of this approach are the restrictive assumptions underlying the standard CAPM, which only holds if either (i) asset returns are normally (and thus symmetrically) distributed or (ii) investors care only about the mean and variance of returns (which implies that they view upside and downside risks with equal distaste). Neither of these assumptions is satisfactory in the private equity area: Private equity returns are not, in general, well described by a normal distribution (see e.g. Cochrane (2005)). Furthermore, investors do distinguish between upside and downside risks. For example, investors typically have a preference for positively skewed returns. If these restrictive assumptions are not met, the results of Leland (1999) highlight that the standard CAPM mismeasures systematic risk and abnormal returns. The Rubinstein–Leland CAPM employed in this paper allows correctly measuring abnormal returns and systematic risk by capturing all elements of risk; including skewness, kurtosis, and all other elements that further describe the return distribution. Finally, another advantage of the method proposed here is that it provides estimates of abnormal returns and systematic risk that are consistent with the *Public Market Equivalent* (PME) measure developed by Kaplan and Schoar (2005), which is a widely used performance metric in the private equity literature and industry (see e.g. Harris et al. (2014)). While Kaplan and Schoar (2005) provide only a heuristic motivation of their measure, Sorensen and Jagannathan (2015) and Korteweg and Nagel (2016) show that the standard PME measure can be derived from the Rubinstein (1976) model under the assumption that investors have logarithmic utility, i.e., a relative risk aversion coefficient of one. In order to obtain consistency with the standard PME measure, we also assume logarithmic utility in deriving the estimators for systematic risk and abnormal returns. However, since log-utility places some unrealistic restrictions on the market risk premium and on the riskless rate, the estimation methodology is also extended to the general utility case in which the relative risk aversion accurately reflects the riskless rates and returns of public equity markets during the sample period.

The developed method is validated using numerical examples and is applied to a unique and comprehensive dataset containing the exact monthly gross of fee cash flows generated by a large number of portfolio company investments from private equity funds. The data come directly from a large general partner network and are less exposed to the self-reporting and survivorship biases that plague standard commercial private equity databases (see Harris et al. (2010) for a discussion). Overall, the data contains 12,565 (7732 venture capital and 4833 buyout) fully liquidated private equity investments from all regions worldwide. This is one of the largest samples yet been used in the literature that estimates abnormal returns and systematic risk of private equity. Previous research (e.g. Driessen et al. (2012) and Ang et al. (2013)) often uses *fund* level data to estimate abnormal returns and risk loadings. The main advantage of using *deal* level data, as done here, is that this leads to substantially more independent observations and consequently greater statistical power.

In order to assess whether the standard CAPM leads to biased estimates of abnormal returns and systematic risk of private equity investments, the analysis starts by examining the skewness and coskewness of the sample investments. As expected, the sample venture capital and buyout investments both show a large and statistically significantly positive return skewness. To reflect the argument that investors are not compensated for diversifiable skewness in equilibrium (see Rubinstein (1973) and Ingersoll (1975)), we also explore systematic skewness (i.e., coskewness) of the sample investments. Coskewness represents the contribution of an asset to the skewness of the market portfolio. A negative (positive) coskewness means that the asset is adding negative (positive) skewness. Despite the large positive skewness reported, we interestingly find a statistically significantly negative coskewness of the sample venture capital investments. In other words, venture capital investments and the market portfolio tend to exhibit extreme negative returns at the same time and the positive skewness of the returns represents diversifiable risk. According to the theory, investors require an additional premium for holding assets with negative coskewness (see Harvey and Siddique (2000)). Assets with negative coskewness should therefore earn higher expected returns than implied by the standard CAPM. Consistent with this theoretical prediction, we find a markedly lower alpha and a higher systematic risk of venture capital than reported in previous studies that estimate a standard CAPM. In the general utility case where the coefficient of relative risk aversion is calculated using market returns and the riskless rate, the estimated annual alpha before fees equals 13.31% and beta equals 3.31. For venture capital deals, previous studies by Cochrane (2005), Ewens (2009), and Korteweg and Sorensen (2010) estimate annual alphas before fees that exceed 30% and report betas that are consistently below 3.31. The lower estimation result for alpha is consistent with the fact that our estimation methodology takes into account that investors require a premium for negative coskewness of venture capital investments. In addition, the higher beta risk found in this study implies that ignoring the negative coskewness underestimates the systematic risk of venture capital investments.

Despite the large positive skewness found for buyout investments, the analysis reveals that coskewness of these investments is not statistically significantly different from zero. In other words, the positive skewness of buyout investments represents diversifiable and not systematic risk. In this case, the theory suggests that the estimates of systematic risk and abnormal returns from the Rubinstein–Leland CAPM are similar to those found when estimating a standard CAPM. Consistent with this prediction, we estimate alphas and betas that are in line with previous empirical evidence. In the general utility case, our estimated annual alpha before fees equals 8.84% and the estimated beta equals 1.30. On the deal level, previous studies by Franzoni et al. (2012) and Axelson et al. (2013) report similar annual alphas before fees of 9.3% and 8.3%-8.6%, respectively. In addition, our estimate for systematic risk of 1.30 is consistent with previous estimates by Driessen et al.

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