Performance Measurement in Private Equity: *Another Look at the Lagged Beta Effect*

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In 2002, we published the first article on using lagged betas to measure the embedded systematic risk in private equity portfolios (Anson [2002]). This was an important step to understand the relationship between private equity portfolio returns and the returns of the public stock market. Additionally, it provided a robust way to include private equity as an asset class in the asset allocation decision. Last, the use of lagged betas allowed asset owners to better determine the true alpha associated with their investment in private equity.

To summarize the problem, most of the capital committed to private equity is managed by intermediaries—limited partnerships that collect pools of investment capital. Each pool is managed by a general partner, who is responsible for finding suitable companies in which to invest the private capital. The general partner of a private equity limited partnership has broad discretion not only to make investments but also to determine their "fair value." Without publicly traded prices to determine fair value, most general partners have considerable flexibility to determine what is the "fair value" of the private companies contained in the private equity pool.

As a result, most private equity limited partnerships hold illiquid equity stakes in companies with no observable market price. The illiquid nature of these securities can lead to non-synchronous price changes in the private equity portfolio compared to the movement of the public stock markets. Private equity valuations might suffer from "stale pricing"—that is, their marked value may not be "fresh" in the sense that the value of the private equity investments may not reflect current movements in the overall public stock and financial markets. Consequently, the value of private equity investments may lag the price movements of the public securities markets. Stale pricing can result in the underestimation of systematic (beta) risk and the overestimation of alpha (skill). Recent research indicates that private equity returns outperform the public stock markets (Harris, Jenkinson, and Kaplan [2013]). However, to fully understand the extent of this outperformance, it important to understand what is beta and what is alpha associated with private equity returns.

The problem is highlighted in Exhibit 1. This is a measure of serial correlation between private equity returns.[1] Under the random walk theory—a variant of the efficient markets hypothesis—you cannot use past prices to predict the direction of future prices. Refined into a testable hypothesis, the serial correlation of returns associated with a security, asset class, etc., should be zero—that there is no predictive correlation between security returns over time. A significant serial correlation would demonstrate that there is some

lagging effect—that past prices do, in fact, have some influence on current prices.

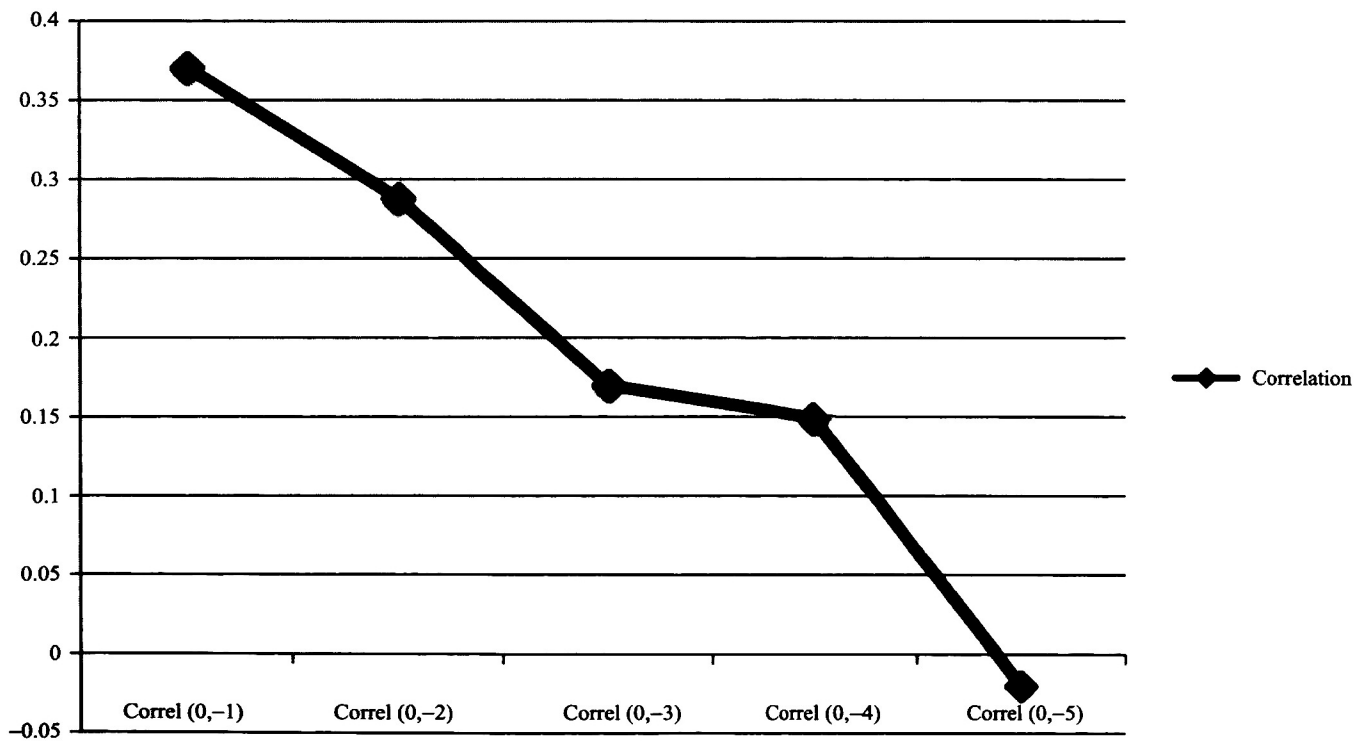
Exhibit 1 demonstrates that there is significant serial correlation embedded in private equity returns. This serial correlation is statistically significant up to four lagged quarters of private equity returns. In other words, up to one year of prior returns have some influence on the current return to private equity. This refutes the efficient market hypothesis—private equity returns do not follow a random walk. Another way to consider this issue is the persistence in private equity returns. Harris et al. [2013] demonstrate that top-performing private equity funds have a greater likelihood of maintaining their performance in the future.

Following this observation, Anson [2002] demonstrated that there was a significant lagged beta effect for leveraged buyouts, venture capital, and mezzanine debt. Since betas are linearly additive, the sum of the lagged betas provides an estimate of the total systematic risk embedded within private equity portfolios. Using lagged betas for up to four prior quarters of public stock market returns, we found that the systematic risk embedded in private equity returns was approximately double, and the concomitant alpha declined by one-half. These results were confirmed by Anson [2007] and Jian Fan et al. [2013].

In addition to the lagged beta effect, Anson [2002, 2007] also documented a behavioral impact. Dividing the data into up versus down markets, Anson found that private equity managers marked down their portfolios quickly in down markets, demonstrating a smaller lagged beta effect, and marked up their portfolios slowly in up markets—a longer lagging effect. This behavioral

EXHIBIT 1

Serial Correlation of Private Equity



Time Lag	Correlation	*t*-stat	*p*-value
Correl (0,–1)	0.37	4.17	0.000001
Correl (0,–2)	0.29	3.14	0.001
Correl (0,–3)	0.17	1.72	0.074
Correl (0,–4)	0.15	1.58	0.106
Correl (0,–5)	–0.02	–0.21	–0.92

effect was present across every class of private equity. Anson hypothesized that this behavioral effect was due to the monitoring of the general partner by the limited partners, who wished the general partners to be conservative in their portfolio company valuations.

NEW ACCOUNTING RULES FOR PRIVATE EQUITY

The prior studies of lagged Private Equity beta were all performed prior to Financial Accounting Statement No. 157, *Fair Value Measurement* (FAS 157), and Accounting Standards Codification Topic 820, *Fair Value Measurement* (ASC 820). FAS 157 was released in September 2006 and became effective for fiscal years beginning November 15, 2007, and thereafter. FAS 157 officially became ASC 820 in September 2009.

ASC 820 is the authoritative statement on how entities should measure and disclose the fair value of assets in their financial statements. Effectively, ASC 820 requires assets to be marked to a fair value every accounting period—recording at historical cost is no longer an option. The central part of ASC 820 is a three-level fair valuation hierarchy for the classification of inputs used to determine the fair value of an asset. Often these are referred to as Level 1, Level 2, or Level 3 assets.

- **Level 1** Assets have observable market prices—quoted prices from a stock exchange, electronic communications network, or some other source of objective pricing.
- **Level 2** Assets don't have an observable price, but there are inputs other than quoted prices, such as observable prices for similar assets or liabilities.
- **Level 3** Assets do not have inputs that come from observable prices. Typically, these assets rely on management estimates and can be based on a variety of models.

Under ASC 820, private operating companies—otherwise known as private equity—are categorized as Level 3 investments because of the lack of observable inputs. Prior to ASC 820, private equity funds recorded the fair value of those private operating companies at their initial transaction cost and subsequently made adjustments only when there was a new round of financing, recapitalization, or some other infusion of new capital.

Under ASC 820, the initial transaction price can be considered as a starting point for valuation, but it cannot be presumed to be fair value. ASC 820 accepts several methods to determine the fair value of private equity fund investments:

- A discounted cash flow analysis
  - The private equity fund manager can apply probability weights to future cash flows.
  - And the private equity fund manager has discretion in the choice of discount rate to value the stream of future cash flows.
- A market-comparable approach
  - A comparative analysis of acquisition multiples for public companies in the same or similar industries.
  - A comparative analysis using pricing multiples of EBITDA, revenue, and price-to-book in similar industries.
  - The private equity fund manager can use his/her judgment as to which companies provide the best comparable measurements.
- Liquidity discounts
  - To reflect the lack of marketability of the private equity investment.
- A control premium
  - To reflect the absolute control that the private equity fund has over a private operating company by virtue of controlling the majority of its stockholders' equity.
- Option pricing models
  - The equity of a private operating company may be viewed as an option on the total assets of the company where the strike price is equal to the outstanding debt. Black and Scholes made this observation in their seminal paper on option pricing.
  - Black-Scholes or other equity option pricing models such as a binomial equity option model.

In sum, under FAS 157/ASC 820, private equity managers retain quite a bit of discretion to determine the market value of their portfolio companies. The question we attempt to answer is whether the fair value implementation of FAS 157/ASC 820 has had an impact in reducing the lagged beta effect previously observed and associated with private equity fund returns.

AN EMPIRICAL TEST

We wish to determine whether the advent of ASC 820 has had an impact on the valuation of private equity such that the lagged beta effect is no longer relevant. We use the Cambridge Associates U.S. Private Equity Index with data back to 1986 as our sample database to test our hypothesis. This index includes data from 1,052 U.S. private equity funds, including leveraged buyouts, growth equity, private equity energy, and mezzanine funds.

Our prior studies (Anson [2002, 2007] used the Thomson Reuters Venture Economics database. However, this database has since been identified by Stucke [2011], Kaplan [2013], and Harris, Jenkinson, and Kaplan [2013] as having significant flaws. Therefore, at the outset, we run the same analysis from our prior articles to determine if the lagged beta effect remains true, using the more robust Cambridge Associates database.

To recap, private equity is an illiquid asset class.

- Valuations may not be contemporaneous with market indexes.
- This can lead to non-synchronous pricing effects.
- And the amount of beta or market risk might be underestimated, whereas the amount of excess return or alpha might be overestimated.

- Therefore, a simple one-period model to determine the beta of private equity may underestimate the true level of systematic risk associated with private equity returns, and inflate the estimate of alpha.
- To correct this problem, we need to perform a multi-period analysis using contemporaneous and lagged market returns to determine the amount of systematic market risk embedded in private equity returns.

Our empirical technology remains the same from our earlier papers (Anson [2002, 2007]. We use the following multivariate regression equation:

- $[R_{i,t}(PE) - Tbill] - \beta_0[R_{M,t} - Tbill] - \beta_1[R_{M,t-1} - Tbill] - \beta_2[R_{M,t-2} - Tbill] \ldots - \beta_n[R_{M,t-n} - Tbill] = \alpha + \varepsilon_{i,t}$

- We regress the returns to private equity on the current public stock market return plus several quarters of prior market returns.
  - Betas are linearly additive, so we can take the sum of the betas to determine the true amount of systematic risk embedded in private equity portfolios.
  - $\beta_0 + \beta_1 + \beta_2 + \ldots \beta_n$ should provide a more accurate picture of how the returns to private equity co-vary with the public securities markets.
  - In addition, by taking into account both contemporaneous and lagged market effects, we should get a better measure of alpha, or manager skill.

Our hypothesis is simple: The adoption of ASC 820 has led to more current valuations of private equity investments such that the lagged beta affect is no longer relevant. To test this theory, we divide up our data sample into two portions: 1986–2007 (pre-FAS 157/ASC 820) and 2008–2013 (post-FAS 157/ASC 820). Although there is a smaller dataset post-FAS 157/ASC 820, there are sufficient data points to conduct an empirical test on whether there has been a change in the lagged beta effect.

RESULTS

A threshold issue is to determine the number of lagged periods to fully measure the impact of market returns on private equity returns. We answer this question two ways. First, Exhibit 1 provides the best clue. It shows that there is considerable serial correlation between private equity returns for up to four lagged quarters—a good indication that this is the length of time for which lagged betas would be statistically significant. The second way is simple trial and error: Keep including lagged beta terms until they are no longer economically and statistically relevant.

Exhibit 2 demonstrates the lagged beta effect associated with private equity returns. We use the Russell 1000 and Russell 2000 stock market indexes to ensure that there are no capitalization range or size effects. For the Russell 1000, the single period CAPM model shows a market beta of 0.40 and a quarterly alpha of 2.6%. Both the alpha and beta estimates are statistically significant

at the 1% level. The R^2 for the single-period regression model is 0.49.

Using the multi-period model, we can observe that there is significant lagged systematic market risk associated with private equity returns. We find that the lagged market betas are statistically significant for up to four prior quarters of public stock market returns. We included (but do not report here) up to six lagged periods for both the Russell 1000 and Russell 2000. However, consistent with the serial correlation demonstrated in Exhibit 1, we found that the lagged betas with respect to both stock market indexes remained significant only with respect to the four prior quarters of public stock market returns.

For the Russell 1000, Exhibit 2 demonstrates that the contemporaneous beta plus each of the four lagged beta estimates is economically and statistically significant. Compared to the single beta regression equation, the total beta estimate doubles to 0.803, the R^2 increases to 0.63, and the alpha estimate declines to 1.9%.

For the Russell 2000, we find similar results. The single-period beta is 0.29, the single-period alpha is 2.8%, and the R^2 is 0.42. In the multi-period model, all four of the lagged betas are statistically significant and the total beta is 0.684 with an R^2 of 0.53. The alpha also declines to 1.9%, but remains statistically significant.

To recap, there is significant systematic risk embedded in private equity returns, which must be

EXHIBIT 2
Single and Lagged Beta

Panel A: Single Beta Russell 1000, 1986–2013
ANOVA

	df	SS	MS	F	*p*-level
Regression	1.	0.122	0.122	100.573	0.
Residual	105.	0.127	0.001		
Total	106	0.249			
R-squared	**0.49**				
Total number of observations	107.				

	Coefficients	Standard Error	*t*-stat	*p*-level
Intercept	0.026	0.003	7.374	0.000010
Russell 1000	0.399	0.04	10.029	0.000000

Multiple Beta Russell 1000, 1986–2013
ANOVA

	df	SS	MS	F	*p*-level
Regression	5.	0.153	0.031	32.662	0.
Residual	97.	0.091	0.001		
Total	102	0.245			
R-squared	**0.63**				
Total number of observations	103.				

	Coefficients	Standard Error	*t*-stat	*p*-level
Intercept	0.019	0.003	5.429	0.
Ru1000	0.414	0.036	11.499	0.
Ru1000 (–1)	0.133	0.036	3.662	0.
Ru1000 (–2)	0.08	0.035	2.242	0.027
Ru1000 (–3)	0.086	0.036	2.414	0.018
Ru1000 (–4)	0.091	0.035	2.571	0.012
Total Beta	**0.803**			

EXHIBIT 2 *(Continued)*

Panel B: Single Beta Russell 2000, 1986–2013

ANOVA

	df	SS	MS	F	Significance F
Regression	1.000	0.103	0.103	73.466	0.000
Residual	102.000	0.142	0.001		
Total	103.000	0.245			
R-squared	**0.42**				
Observations	104				

	Coefficients	Standard Error	*t*-stat	*p*-level
Intercept	0.028	0.004	7.511	0.000
Russell 2000	0.293	0.034	8.571	0.000

Multiple Beta Russell 2000, 1986–2013

ANOVA

	df	SS	MS	F	Significance F
Regression	5.000	0.131	0.026	22.395	0.000
Residual	98.000	0.114	0.001		
Total	103.000	0.245			
R-squared	**0.53**				
Observations	104				

	Coefficients	Standard Error	*t*-stat	*p*-level
Intercept	0.019	0.004	4.845	0.000
Ru2000	0.326	0.032	10.199	0.000
Ru2000 (–1)	0.120	0.032	3.770	0.000
Ru2000 (–2)	0.091	0.032	2.856	0.005
Ru2000 (–3)	0.094	0.032	2.978	0.004
Ru2000 (–4)	0.052	0.031	1.667	0.099
Total Beta	**0.684**			

measured beyond the current market returns. In fact, our results demonstrate that up to one year of prior public market returns have a statistically significant impact on the current returns to private equity. This is consistent with the studies of Anson [2002, 2007] and Jian Fan et al. [2013].

Our next step is to determine whether the advent of FAS 157/ASC 820 has had an impact on the lagged market risk effect associated with private equity returns. Our hypothesis is that the new current market value rules required under FAS 157/ASC 820 should reduce the lagged beta effect associated with private equity returns.

We divide our data into two time periods: pre-FAS 157 and post-FAS 157. We then conduct a Chow Test to determine if there is any significant difference in the lagged beta effect between the two periods.[2] The Chow Test can be used to observe different data relationships that may occur across different time periods, genders, calendar quarters, etc. The test is based on measuring the difference between the residual sum of squares (RSS) between the two regression equations. A significant difference between the RSS of the two regression periods would indicate that there has been a change in the relationship between the underlying economic variables, or that the lagged beta effect has changed.

Reiterating our hypothesis, we expect that there will be a smaller lagged beta effect after the adoption of FAS 157/ASC 820. Our initial lagged beta regression results demonstrate that the Russell 1000 is the better

market index to capture the systematic returns to private equity. Consequently, we focus on this index to determine if there is a change in the lagged beta effect post-FAS 157.

Exhibit 3 presents our results. We show the lagged beta regressions for the full time period of 1986–2013 and for the two subperiods: 1986–2007 and 2008–2013.[3] We also include the data for the Chow Test, which results in a test statistic distributed along an F distribution.

First, we note that the total lagged beta for both time periods is very similar: 0.79 for the 1986–2007 time period, and 0.75 for the 2008–2013 period. We also observe that the individual lagged betas in both subperiods are still statistically significant, but the *t*-statistics are lower. This may be due to the smaller sample sizes of each regression. What is most interesting is that the R^2 measure is highest for the post-FAS 157 period. With an R^2 measure of 0.89, the lagged beta effect appears to

EXHIBIT 3
Chow Test of Multiple Regressions

Panel A: Multiple Beta Russell 1000, 1986–2013
ANOVA

	df	SS	MS	F	*p*-level
Regression	5.	0.153	0.031	32.662	0.
Residual	97.	0.091	0.001		
Total	102	0.245			
R-squared	**0.63**				
Total number of observations	103.				

	Coefficients	Standard Error	*t*-stat	*p*-level
Intercept	0.019	0.003	5.429	0.
Ru1000	0.414	0.036	11.499	0.
Ru1000 (–1)	0.133	0.036	3.662	0.
Ru1000 (–2)	0.08	0.035	2.242	0.027
Ru1000 (–3)	0.086	0.036	2.414	0.018
Ru1000 (–4)	0.091	0.035	2.571	0.012
Total Beta	**0.803**			

Panel B: Multiple Beta Russell 1000, 1986–2007
ANOVA

	df	SS	MS	F	Significance F
Regression	5.000	0.092	0.018	17.087	0.000
Residual	77.000	0.083	0.001		
Total	82.000	0.175			
R-squared	**0.53**				
Observations	83				

	Coefficients	Standard Error	*t*-stat	*p*-level
Intercept	0.020	0.004	4.517	0.000
Ru1000	0.397	0.048	8.310	0.000
Ru1000 (–1)	0.121	0.047	2.584	0.012
Ru1000 (–2)	0.075	0.047	1.601	0.114
Ru1000 (–3)	0.081	0.046	1.752	0.084
Ru1000 (–4)	0.113	0.046	2.446	0.017
Total Beta	**0.79**			

EXHIBIT 3 *(Continued)*

Panel C: Multiple Beta Russell 1000, 2008–2013
ANOVA

	df	SS	MS	F	*p*-level
Regression	5.	0.054	0.011	23.483	0.
Residual	14.	0.006	0.		
Total	19.	0.061			
R-squared	**0.89**				
Total number of observations	20.				

	Coefficients	Standard Error	*t*-stat	*p*-level
Intercept	0.012	0.005	2.393	0.031
Ru1000	0.45	0.047	9.492	0.000
Ru1000 (–1)	0.102	0.05	2.056	0.059
Ru1000 (–2)	0.054	0.052	1.045	0.314
Ru1000 (–3)	0.14	0.051	2.747	0.016
Ru1000 (–4)	0.003	0.048	0.055	0.957
Total Beta	**0.75**			

Panel D: Chow Test

	RSS	N	K variables
1986–2013 RSS(1)	0.091	103	5
1986–2007 RSS(2)	0.083	83	5
2008–2013 RSS(3)	0.006	20	5
RSS(4) = RSS(2) + RSS(3)	0.089		
RSS(5) = RSS(1) – RSS(4)	0.002		
F = [RSS(5)/k]/[RSS(4)/(N1 + N2 – 2k)]	0.418		
Critical F Test			
F = 0.418, df = 5,103			
Prob (F > 3.13)	0.10		
Prob (F > 4.41)	0.05		
Prob (F > 9.13)	0.01		

have the greatest explanatory power *after* the adoption of FAS 157—contrary to our initial hypothesis.

To empirically test our hypothesis, we conduct a Chow Test which is distributed F with 5, 102 degrees of freedom. Our null hypothesis is that the pre-FAS 157 and post-FAS 157 regression equations will demonstrate a different lagging effect. The F test is given at the bottom of Exhibit 3, along with the p-value.

We can see that the F statistic is very small at 0.418 and does not even come close to exceeding the critical F value for a 10% level of confidence. Consequently, we reject our null hypothesis that the two time periods result in a different lagging effect. Instead, we conclude that the lagged beta effect has the same explanatory power both pre- and post-FAS 157. Our initial hypothesis is refuted—FAS 157 has not had a material impact on the lagged beta effect associated with private equity returns.

In an attempt to explain this unexpected result, we recall the flexibility that is allowed under FAS 157/ASC 820 to determine market values of Level III assets. As an example of this flexibility, and the discretion that remains with a general partner of a private equity fund to determine fair value, consider the following language from the 2012 Blackstone 10-K financial statements regarding the valuation of its private equity portfolio:

Private Equity Investments—The fair values of private equity investments are determined by reference to projected net earnings, earnings before interest, taxes, depreciation and amortization ("EBITDA"), the discounted cash flow method, public market or private transactions, valuations for comparable companies and other measures which, in many cases, are unaudited at the time received. Valuations may be derived by reference to observable valuation measures for comparable companies or transactions (e.g., multiplying a key performance metric of the investee company such as EBITDA by a relevant valuation multiple observed in the range of comparable companies or transactions), adjusted by management for differences between the investment and the referenced comparables, and in some instances by reference to option pricing models or other similar methods. Private equity investments may also be valued at cost for a period of time after an acquisition as the best indicator of fair value.

We conclude that there remains sufficient discretion with the private equity general partner to mark its portfolio such that the lagged beta effect remains in full force post-FAS 157.

BEHAVIORAL IMPACT

In our prior studies (Anson [2002, 2007]), we documented a behavioral effect associated with lagged betas. Specifically, we found that the lagged beta effect was greater in positive-performing stock markets and smaller in negative-performing stock markets. In other words, private equity managers actively marked their portfolio companies. But, contrary to our initial hypothesis, we found that private equity managers were slower to mark up their portfolio companies and faster to mark them down. We now examine whether this behavior remains a significant contributor to the lagged beta effect in private equity portfolios.

Using the same dummy variable technology of Anson [2002, 2007], we repeat our lagged beta analysis with one addition: We divide the world into up and down markets. Dummy variables are an excellent way to divide an economic period of study into binary states. In this manner, we look to see if there is a greater or smaller lagged beta effect in up versus down markets. If there is no private equity behavior at work, then the lagged betas should be equivalent in both up and down markets. If we observe significantly different betas between the two market environments, we can conclude that there is an element of active portfolio management by private equity managers.

Exhibit 4 presents our results. First, we look at the whole time period of 1986–2013. We confirm that a behavioral element still has an impact on the lagged beta effect. Exhibit 4 shows that the lagged beta effect for up stock markets has a statistically significant lagged beta out to period (–4), while for down stock markets, the lagged beta effect is statistically significant only for the first lagged quarter—and then only weakly significant at an 11% level of confidence. This demonstrates that private equity managers are slower to mark up the value of their portfolio companies in up markets, and faster to mark down the value of their portfolio companies in down markets.

Also of interest is how the alpha intercept changes dramatically from up to down markets. In up stock markets, the alpha generated by private equity managers is a –1.1% per quarter (–4.4% on an annual basis), while in down markets, it is an amazing +5.8% per quarter, or 23.2% on an annual basis. We submit that private equity managers do not suddenly lose their alpha-generating talent in up markets only to turn into alpha geniuses in down markets. Rather, the truth lies somewhere in between.

In Exhibit 5, we divide up our behavior examination into pre-FAS 157 and post-FAS 157 time periods. First, for the period 1986–2007, it is less clear whether there was a distinct behavior at work. We do not observe a significant difference in the lagged impact in up versus down markets. In both states of the public stock markets, the lagged betas are mostly insignificant. However, when we add up the total beta, it is higher for down markets (1.05) than it is for up markets (0.86). Also, there remains a significant difference between the alpha intercepts. In up markets, the alpha is close to 0, at 0.2%, while in down markets, it is 5.9% per quarter.

In the post-FAS 157 data, we do see a marked difference in the lagged beta effect. For up markets, the lagged betas are more significant than in down markets. In fact, some of the lagged betas in down markets are even negative—although statistically insignificant. Also, the total beta expands to 1.5 for up markets, whereas for down markets it declines to 0.87. Notice again the

EXHIBIT 4
Up Markets vs. Down Markets

Panel A: Russell 1000, 1986–2013, Up Markets
ANOVA

	df	SS	MS	F	Significance F
Regression	5.000	0.080	0.016	9.438	0.000
Residual	98.000	0.165	0.002		
Total	103.000	0.245			
R-squared	**0.325**				
Observations	104				

	Coefficients	Standard Error	*t*-stat	*p*-level
Intercept	–0.011	0.009	–1.239	0.218
Ru1000 (0)	0.501	0.083	6.010	0.000
Ru1000 (–1)	0.183	0.080	2.276	0.025
Ru1000 (–2)	0.146	0.080	1.825	0.067
Ru1000 (–3)	0.092	0.080	1.140	0.257
Ru1000 (–4)	0.154	0.081	1.907	0.059
Total Beta	**1.075**			

Panel B: Russell 1000, 1986–2013, Down Markets
ANOVA

	df	SS	MS	F	Significance F
Regression	5.000	0.129	0.026	21.662	0.000
Residual	98.000	0.116	0.001		
Total	103	0.245			
R-squared	**0.525**				
Observations	104				

	Coefficients	Standard Error	*t*-stat	*p*-value
Intercept	0.058	0.005	12.634	0.000
Ru1000 (0)	0.644	0.068	9.525	0.000
Ru1000 (–1)	0.111	0.068	1.621	0.108
Ru1000 (–2)	0.087	0.068	1.284	0.202
Ru1000 (–3)	0.075	0.068	1.101	0.273
Ru1000 (–4)	0.062	0.067	0.930	0.355
Total Beta	**0.979**			

large difference in the alpha generated between up versus down markets. In up markets, the alpha is –6.1% per quarter, while it is +5.4% for down markets. This is the largest asymmetry of alpha encountered in our lagged beta analysis and provides critical evidence of private equity manager behavior at work. Otherwise, we should expect the alpha to be the same in up versus down markets. More interesting, it appears that private equity managers have become *even more conservative* post-FAS 157. The lagged betas have the greatest summed value for up markets during 2008–2013 compared to any period that we have observed.

SIZE AND VALUE EFFECTS

In addition to confirming the lagged market beta effect, Jian Fan et al. [2013] also demonstrate a small cap and growth bias to buyout returns. They include the SMB size and HML value effects as identified by Fama and French [1993]. Generally, these effects are referred

to as "style factors." For buyout funds, they find a statistically significant impact for small cap exposure for both the contemporaneous beta and one lagged period and a significant and contemporaneous effect for the growth factor. Surprisingly, for venture capital, neither the small cap factor nor the growth was statistically significant. Jegadeesh et al. [2010] also find a significant small cap effect with respect to private equity and venture capital. However, contrary to Jian Fanet et al. [2013], they found that buyout returns were more sensitive to the value factor than the growth factor. For VC funds, there was no impact for either growth or value.

We review the size and value effects as well, but we employ a short cut. We use market benchmarks that embed the size and value effects directly into the measurement of stock market returns. Specifically, we measure the systematic component of private equity returns using the following four stock market style indexes: the

EXHIBIT 5

Up Markets vs. Down Markets (Subperiods)

Panel A: Russell 1000, 1986–2007, Up Markets
ANOVA

	df	SS	MS	F	Significance F
Regression	5.000	0.049	0.010	6.017	0.000
Residual	77.000	0.126	0.002		
Total	82.000	0.175			
R-squared	**0.28**				
Observations	83				

	Coefficients	Standard Error	*t*-stat	*p*-level
Intercept	0.002	0.011	0.204	0.839
Ru1000 (0)	0.495	0.098	5.074	0.000
Ru1000 (–1)	0.130	0.093	1.401	0.165
Ru1000 (–2)	0.051	0.093	0.545	0.588
Ru1000 (–3)	0.039	0.093	0.426	0.672
Ru1000 (–4)	0.148	0.092	1.603	0.113
Total Beta	**0.864**			

Panel B: Russell 1000, 2008–2013, Up Markets
ANOVA

	df	SS	MS	F	Significance F
Regression	5.000	0.043	0.009	6.709	0.002
Residual	15.000	0.019	0.001		
Total	20.000	0.062			
R-squared	**0.69**				
Observations	21				

	Coefficients	Standard Error	*t*-stat	*p*-level
Intercept	–0.061	0.017	–3.664	0.002
Ru1000 (0)	0.624	0.154	4.062	0.001
Ru1000 (–1)	0.311	0.160	1.949	0.070
Ru1000 (–2)	0.212	0.169	1.255	0.229
Ru1000 (–3)	0.282	0.173	1.624	0.125
Ru1000 (–4)	0.163	0.162	1.010	0.329
Total Beta	**1.592**			

EXHIBIT 5 *(Continued)*

Panel C: Russell 1000, 1986–2007, Down Markets
ANOVA

	df	SS	MS	F	Significance F
Regression	5.000	0.073	0.015	10.889	0.000
Residual	77.000	0.103	0.001		
Total	82.000	0.175			
R-squared	**0.41**				
Observations	83				

	Coefficients	Standard Error	*t*-stat	*p*-value
Intercept	0.059	0.005	11.259	0.000
Russell 1000 (0)	0.571	0.089	6.423	0.000
Russell 1000 (–1)	0.122	0.089	1.366	0.176
Russell1000 (–2)	0.147	0.088	1.667	0.100
Russell 1000 (–3)	0.101	0.088	1.146	0.255
Russell 1000 (–4)	0.111	0.088	1.260	0.211
Total Beta	**1.052**			

Panel D: Russell 1000, 1986–2013, Down Markets
ANOVA

	df	SS	MS	F	Significance F
Regression	5.000	0.054	0.011	18.830	0.000
Residual	15.000	0.009	0.001		
Total	20.000	0.062			
R-squared	**0.86**				
Observations	21				

	Coefficients	Standard Error	*t*-stat	*p*-value
Intercept	0.054	0.009	5.893	0.000
Russell 1000 (0)	0.759	0.087	8.762	0.000
Russell 1000 (–1)	0.076	0.089	0.855	0.406
Russell1000 (–2)	–0.017	0.090	–0.195	0.848
Russell 1000 (–3)	0.078	0.088	0.883	0.391
Russell 1000 (–4)	–0.027	0.087	–0.312	0.759
Total Beta	**0.868**			

Russell 1000 Large Cap Value Index, the Russell 1000 Large Cap Growth Index, the Russell 2000 Small Cap Value Index, and the Russell 2000 Small Cap Growth Index. These four indexes specifically adjust for the style effects of size and value.

Following the analysis above, we use the lagged beta technology to determine the impact of these style effects on private equity returns. Reviewing the results of Jian Fan et al. [2013], we would expect that the Russell 2000 Small Cap Growth Index to demonstrate the greatest explanatory power of private equity returns either in the total lagged beta or in the R^2 goodness of fit with respect to the regression equation.

Exhibit 6 presents the results of our lagged beta analysis with respect to the style indexes. Unfortunately, these style indexes were not fully introduced until 1995. Therefore, our time period for data analysis is shorter than the full data set of the previous exhibits.

First, we look at the Russell 2000 Small Cap Growth Index. Using this index, we achieve an R^2 of 76%, a total beta of 0.69, and each of the lagged betas is statistically significant at the 1% level or lower. Last, the

alpha is 1.7%. Comparing this to the Russell 2000 Small Cap Value index, we find an R^2 of 0.42, a total lagged beta of 0.57, and the lagged betas are either statistically insignificant, or only weakly insignificant at the 13% level (Russell Small Cap Value (–2)) or 12% level (Russell Small Cap Value (–3)). Last, the alpha intercept is larger at 2%. These results establish that the Small Cap Growth style effect has greater explanatory power for lagged beta exposure than the Small Cap Value style effect.

Turning to large cap stock market exposure, we first look at the Russell 1000 Large Cap Growth Index. We find an R^2 of 71%, with a total lagged beta of 0.75, and all of the lagged betas are statistically significant at the 9% level or better. The alpha intercept is 2.3%. For the Russell 1000 Large Cap Value index, the R^2 measure

EXHIBIT 6
Small Cap vs. Large Cap, Growth vs. Value

Panel A: Russell 2000 Growth, 1995–2013
ANOVA

	df	SS	MS	F	Significance F
Regression	5.000	0.167	0.033	38.295	0.000
Residual	62.000	0.054	0.001		
Total	67.000	0.221			
R-squared	**0.76**				
Observations	69				

	Coefficients	Standard Error	*t*-stat	*p*-level
Intercept	0.017	0.004	4.126	0.000
Ru2000 Growth	0.345	0.027	12.908	0.000
Ru2000 Growth (–1)	0.117	0.027	4.410	0.000
Ru2000 Growth (–2)	0.072	0.027	2.729	0.008
Ru2000 Growth (–3)	0.086	0.026	3.262	0.002
Ru2000 Growth (–4)	0.068	0.026	2.584	0.012
Total Beta	**0.69**			

Panel B: Russell 1000 Growth, 1995–2013
ANOVA

	df	SS	MS	F	Significance F
Regression	5.000	0.158	0.032	31.466	0.000
Residual	63.000	0.063	0.001		
Total	68.000	0.221			
R-squared	**0.71**				
Observations	69				

	Coefficients	Standard Error	*t*-stat	*p*-value
Intercept	0.023	0.004	5.575	0.000
Ru1000 Growth	0.412	0.037	11.050	0.000
Ru1000 Growth (–1)	0.113	0.037	3.018	0.004
Ru1000 Growth (–2)	0.074	0.038	1.962	0.054
Ru1000 Growth (–3)	0.064	0.038	1.707	0.093
Ru1000 Growth (–4)	0.088	0.037	2.357	0.022
Total Beta	**0.750**			

EXHIBIT 6 *(Continued)*

Panel C: Russell 2000 Value, 1995–2013
ANOVA

	df	SS	MS	F	Significance F
Regression	5.000	0.093	0.019	9.205	0.000
Residual	63.000	0.128	0.002		
Total	68.000	0.221			
R-squared	**0.42**				
Observations	69				

	Coefficients	Standard Error	*t*-stat	*p*-value
Intercept	0.020	0.007	3.108	0.003
Ru2000 Value	0.345	0.052	6.584	0.000
Ru2000 Value (–1)	0.032	0.052	0.616	0.540
Ru2000 Value (–2)	0.080	0.052	1.530	0.131
Ru2000 Value (–3)	0.082	0.052	1.560	0.124
Ru2000 Value (–4)	0.029	0.052	0.559	0.578
Total Beta	**0.57**			

Panel D: Russell 1000 Value, 1995–2013
ANOVA

	df	SS	MS	F	Significance F
Regression	5.000	0.130	0.026	18.140	0.000
Residual	63.000	0.091	0.001		
Total	68.000	0.221			
R-squared	**0.59**				
Observations	69				

	Coefficients	Standard Error	*t*-stat	*p*-value
Intercept	0.021	0.005	4.256	0.000
Ru1000 Value	0.452	0.052	8.602	0.000
Ru1000 Value (–1)	0.094	0.052	1.794	0.078
Ru1000 Value (–2)	0.102	0.053	1.931	0.058
Ru1000 Value (–3)	0.127	0.053	2.397	0.020
Ru1000 Value (–4)	0.078	0.053	1.477	0.145
Total Beta	**0.85**			

declines to 59%, although the total beta increases to 0.85. However, the lagged beta effect is not as strong, as the fourth lagged beta has a *t* statistic of only 1.48, which is significant only at the 14.5% level. The alpha intercept increases slightly, to 2.1%.

Comparing the growth versus value style effect, these results document that the growth effect has a greater impact in explaining the lagged beta effect using both large cap and small cap stock market indexes. This result is consistent with the results of Jian Fan et al. [2013] and contrary to the findings of Jegadeesh et al. [2010].

However, it is less clear whether there is a size effect in our lagged beta equations. First, from Exhibit 2, we found that over the full time period of 1986–2013, the Russell 1000 had greater explanatory power than the Russell 2000. However, reviewing the 1995–2013 period, when the Russell style indexes were fully implemented, we find that the Russell 2000 Small Cap Growth Index had more explanatory power than the

Russell 1000 Large Cap Growth Index. The R^2 for the Russell 2000 Small Cap index is greater than that for the Russell Large Cap Growth Index and the beta coefficients have greater statistical significance in the Russell 2000 Small Cap Growth Index. As a result, our results are mixed. The evidence from 1995–2013 support the conclusions of Jian Fan et al. [2013] of a small cap effect, but the full period reveals a bias toward large-cap market exposure.

CONCLUSION

First, replicating our prior research, but using the more robust Cambridge Economics private equity database, we find a lagged beta effect for up to four prior quarters of public stock market returns. This is also consistent with the results of Jian Fan et al. [2013]. We also find total stock market betas consistent with our prior research, with estimates in the 0.8 range.

Second, we designed a test to determine if the adoption of new accounting rules that require current mark-to-market valuation of balance sheet assets has had an impact on the lagged beta phenomenon associated with private equity returns. Specifically, we measured the lagged beta effect pre- and post-FAS 157 and applied a Chow Test to determine if there was a significant change in the lagged beta effect after the adoption of FAS 157. Our results found no change in the lagged beta effect after the adoption of FAS 157.

Third, we found that the behavioral element associated with private equity returns remains intact. Consistent with our prior research, we found a greater beta lagging effect associated with up markets compared to down markets. This demonstrates that private equity managers are slower to mark up the values of the private company investments and faster to mark down the value of those private assets. In fact, our results indicate that post-FAS 157, private equity managers are even slower to mark up the value of their private companies while remaining quick to mark down the value of those assets.

Last, we used style-based stock market indexes to see which had the greatest explanatory power associated with private equity returns. Consistent with Jian Fan et al. [2013], we found that growth style equity indexes had a greater impact on explaining the lagged beta effect associated with private equity. However, with respect to capitalization range, we did not find a consistent small or large cap effect. With respect to the large cap versus small cap style effect, our results were inconsistent.

ENDNOTES

[1]We use the Cambridge Associates U.S. Private Equity Index from 1986–2013. This database includes return data for pooled private equity funds, including leveraged buyouts, growth equity, private equity energy, and mezzanine debt.

[2]The Chow test was designed by Gregory Chow (1960) to test the constancy of coefficients between two groups of observations. It is used to determine whether two regressions yield the same level of explanatory power. It is a five-step test:

1. Combine all observations into one linear regression and obtain the Residual Sum of Squares (RSS); call this RSS1.
2. Run two individual regressions over the two sample sub-periods that are to be tested with sample sizes N1 and N2. Measure the RSS for the two separate regression equations and call these RSS2 and RSS3, which have N1 – k and N2 – k degrees of freedom and where k is the number of coefficients to be estimated.
3. Add RSS2 + RSS3 = RSS4 with degrees of freedom = N1 + N2 – 2k.
4. Measure RSS5 = RSS1 – RSS4.
5. Apply an F test as follows: F = [RSS5/k]/[RSS4/(N1 + N2 – 2k)].

This test parameter is distributed F with degrees of freedom = k, N1 + N2 – k. If the computed F exceeds the critical F, reject the hypothesis that the two regressions are the same.

[3]Note that the Chow Test does not require that the two time periods have an equal number of data points.

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