ALIGNMENT CAPITAL

Opportunity Cost – Private Equity Risk & Correlation with the Public Markets

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This paper builds on the **Long-Nickels index comparison method (ICM)** for calculating the opportunity cost of a private market investment return relative to a public market index return. It introduces an algorithm to apply to the results of an ordinary least squares linear regression of opportunity costs (which ACG refers to as an opportunity cost outcomes method, or OCOM, plot) that will enable you to express the risk of your private equity portfolio in terms directly comparable to that of your public market investments. It also introduces a way to apply **NWTZ performance attribution** to produce multiple OCOM plots that you can use to determine how much of the risk of your private equity portfolio is a product of the weights of its investments (investment selection) and how is a product of the timing with which they were made.

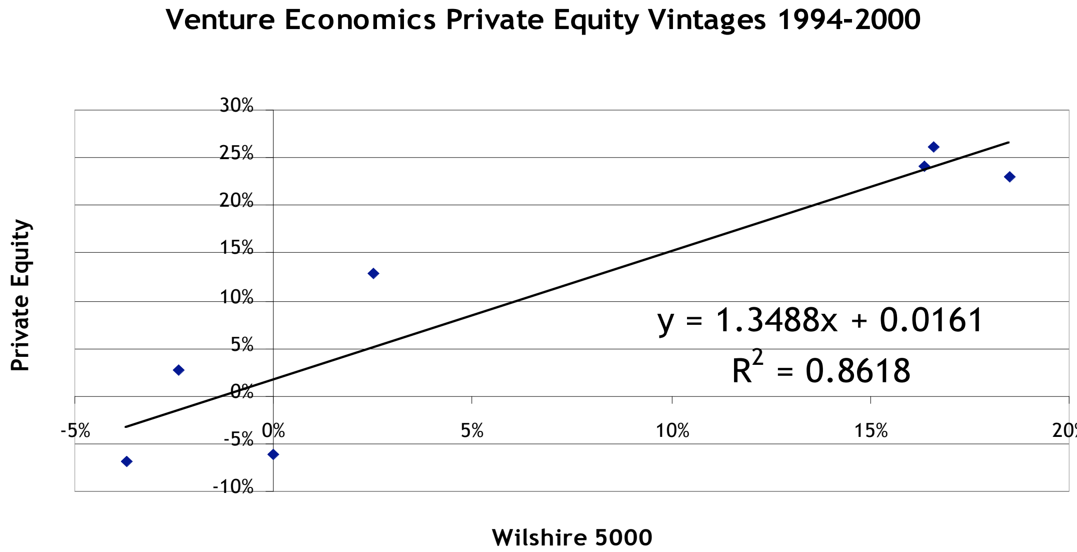
First, recall the basics of ordinary least squares linear regression. The purpose of linear regression is to calculate the slope of a line (usually denoted by the Greek letter β, or the English *beta*) and its *y*-intercept (usually denoted by the Greek letter α, or the English *alpha*) that minimizes the squares of the errors between the points on the calculated line and the various data points that make up the graph. The result of a linear regression is an equation in the form of $y = \beta x + \alpha$. The goodness of fit of the line is usually expressed as R^2, the coefficient of determination, or sometimes its square root, *r* (sometimes the Greek letter ρ, or the English *rho*), the coefficient of correlation. You can think of *r* as the percentage of movement in the dependent variable on the *y*-axis due to the movement of the independent variable on the *x*-axis. In the OCOM plots in this chapter, for each data point the return to a public market index will be the independent variable on the *x*-axis and the return to a private market index will be the dependent variable on the *y*-axis.

In Modern Portfolio Theory, in which linear regression usually places the values of a public market index at particular dates on the *x*-axis and the value of a publicly traded stock on the same dates on the *y*-axis, a steep slope (almost always referred to by practitioners as a high beta) indicates price volatility in excess of the volatility of the index. Beta, in this sense, is a measurement of the nonsystematic risk (the risk in excess of the risk of the market itself) inherent in the stock. Alpha, in the same sense, is the tendency of the stock to deliver a return when the public market index does not. Betas can be negative (indicating an inverse relationship between a stock's price and the price of the index) and so can alphas (indicating that the stock in question will deliver a negative return when the index returns zero).

With that bit of background out of the way, let's start off with a relatively easy example of the OCOM plot using the pooled cash flows of private equity vintages from 1993 to 2000. These private market returns are shown in the table below with their ICM equivalents:

	IRR	
Vintage	Fund	Wilshire
1994	**23.09%**	**18.49%**
1995	**24.11%**	**16.38%**
1996	**26.11%**	**16.60%**
1997	**12.86%**	**2.51%**
1998	**2.75%**	**-2.41%**
1999	**-6.94%**	**-3.70%**
2000	**-6.15%**	**-0.01%**

These returns can be placed into an OCOM plot as follows:



Each of the data points in this graph is an *x,y* pair derived from the ICM IRR of the vintage on the *x*-axis and the private equity IRR of the same vintage on the *y*-axis. You can interpret the beta of 1.35 to mean that the IRR outcomes of the private market vintages are 35% more volatile than the IRR outcomes of the same cash flows in the public markets as measured by the ICM. In other words, on average private market returns in these vintages rise 35% faster than returns to the index as the index's returns increase and decrease 35% faster than the index when the index's returns decrease. The alpha of 1.6% indicates that these private equity vintages could be expected to return an IRR of 1.6% even if the index were to return zero. The square root of R^2, or *r*, the coefficient of correlation, is .927, indicating that 92.7% of the private market's return for the vintages plotted is explained by the return to the public market over the same time period.

The calculation of the regression equation is just the first step, however. Remember that the regression equation above involves IRRs, not the time-weighted rates of return usually connected with risk in the investment industry as a whole. The regression equation above tells us only the **outcome variability**, or private market risk, of the private market vintages relative to the index. In order to know the risk of the private market vintages themselves in the same terms used in the public markets, we have to calculate backwards from the known risk of the index in time-weighted return terms to the unknown risk of the portfolio comprised of the private market vintages. We have to translate private market risk into public market risk.

We begin with the mathematical definition of beta, in which COV_{sm} is the covariance of a stock with the market and σ_m^2 is the variance of the market index over the same time period:

$$\beta_s = \frac{\mathrm{COV}_{sm}}{\sigma^2_m} \quad (1)$$

Substituting the equation for the calculation of covariance, and changing the notation to reflect the contents of the OCOM plot, we obtain the following:

$$\beta_{PE} = \frac{\sigma_{PE}\sigma_{Index} r_{PE,Index}}{\sigma^2_{PE}} \quad (2)$$

Equation (2) can then be solved for private market risk, as follows:

$$\frac{\beta_{PE}\sigma^2_{Index}}{r_{PE,Index}\sigma_{Index}} = \sigma_{PE} \quad (3)$$

We can use Equation 3 to translate the OCOM plot's private market risk to the public market risk used for the publicly-traded portion of your portfolio.

For purposes of our example, we can calculate the standard deviation of the Wilshire 5000 over the time period covered by the OCOM plot as follows:

	Ending	Beginning	Return
1994	4540.6	4798.1	-5.4%
1995	6057.2	4631.4	30.8%
1996	7198.3	6211.8	15.9%
1997	9298.2	7575.8	22.7%
1998	11317.6	9340.8	21.2%
1999	13812.7	11724.8	17.8%
2000	12175.9	13230.6	-8.0%
2001	10707.7	12631.4	-15.2%
2002	8343.2	10564.7	-21.0%
2003	10799.6	8125.1	32.9%
		Mean	9.2%
		Std Dev	19.7%
		Sharpe	0.47

We can then use Equation 3 to calculate the risk/return profile, or efficiency of return, of the private equity vintages in the OCOM plot:

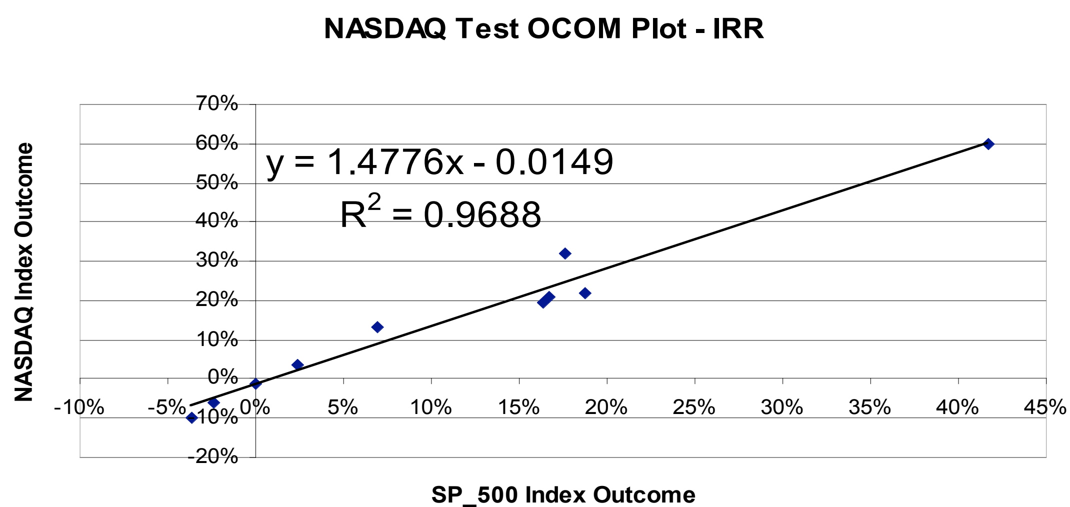
	1/31/94-12/31/03	
Wilshire arithmetic mean	**0.0917**	
Wilshire sigma	**0.1969**	
Sharpe ratio		**0.4656**

beta	alpha	R squared	σ	Sharpe
1.3488	0.0161	0.8618	0.286153	**0.48847**

Thus, over the time period shown the efficiency of return of the private market vintages 1994-2003 was about the same as the efficiency of return of the Wilshire 5000. Given the alpha of the OCOM plot, private equity would seem to be an attractive investment, when compared to the public market over this time period.

It is extremely important to remember, however, that an entire vintage of private equity is composed of a large number of funds. Part of the investment efficiency calculated above is therefore the result of the diversification inherent in the number of funds contained in the calculation. Do not expect to get exactly the same answer when you apply OCOM plot analysis to your own portfolio unless each of your vintages contains a large percentage of the total number funds for that vintage in the Venture Economics database.

One way to check the output of your OCOM plot is to use the process to estimate a known risk (as opposed to using the process to estimate the risk of your own portfolio, as shown above). For example, we can use the same cash flows shown in the example above to estimate the risk of the NASDAQ, which we can calculate separately as a check on our OCOM calculation. The OCOM plot below uses the same vintage pooled cash flows shown in the example above. The vintage IRRs on the *x*-axis are the same as those in the example above, but the vintage IRRs on the *y*-axis were the result of investment in and distribution from the NASDAQ, rather than private equity. .



As the table below shows, the resulting estimate of the risk of the NASDAQ is quite close to its actual risk over the same time period.

$$\frac{\beta_{NASDAQ}\,\sigma^{2}_{Wilshire}}{r_{NASDAQ,Wilshire}\,\sigma_{Wilshire}} = \sigma_{NASDAQ}$$

					Calculated Period	
					1994-2003	
				Wilshire arithmetic mean	0.1166	
				Wilshire sigma	0.2167	
				Sharpe ratio		0.5380
	beta	alpha	R squared		σ	Sharpe
NASDAQ	1.4776	-0.0149	0.9688		0.3254	0.4837

NASDAQ Actual Sharpe	Mean	0.1582	
	Std Dev	0.3549	
	Sharpe		0.4457

A test against an investment of known risk can therefore serve as a quality control measure to assure you that you have a sufficient number of data points to result in an accurate estimate.

As mentioned at the start of this chapter, it is possible to use the NWTZ performance attribution method to determine how much of the beta and alpha shown in the OCOM plot can be traced to investment selection and how much to investment timing. All you have to do is to run an OCOM plot for each of the permutations of the weight and time parameters: an OCOM plot each for neutral-weight, time-zero cash flows; for actual-weight, time-zero cash flows; for neutral-weight, actual-time cash flows; and for the actual-weight, actual-time cash flows with which we began. You can then calculate the extent to which investment selection (in this case, the weighting of the vintages) and timing (the order in which they occurred) affected the portfolio's OCOM plot beta and alpha.

The various permutations of these OCOM plots for the example vintages, and their attribution, are shown in the table below:

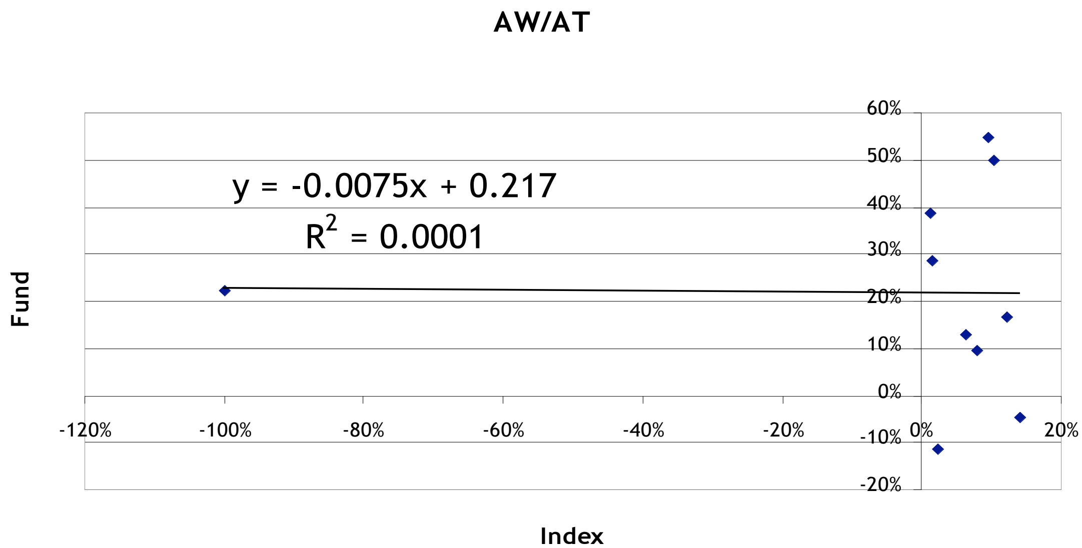
		beta	alpha
	I (NW/ZT)	1.0994	0.0598
	II (NW/AT)	1.1113	0.0547
	IV (AW/AT)	1.3488	0.0161
I	Base	1.0994	0.0598
II-I	Selection	0.0119	-0.0051
IV-II	Timing	0.2375	-0.0386
IV	Manager's return	1.3488	0.0161
I + II	**Manager's control**	1.1113	0.0547

This result shows that the base portfolio has a beta of almost exactly one (i.e., has about the same outcome volatility as the index) and a strong alpha of 5.98%. Selection, or vintage weighting, has almost no effect on either beta or alpha, but timing, or the order in which the vintages occurred, adds .2375 to the beta and subtracts 3.86% from the alpha.

All of the analytical work above can also be applied to your investment portfolio in many different ways, including sub-asset class by vintage, vintage by fund and as many other ways as you have the data to permit.

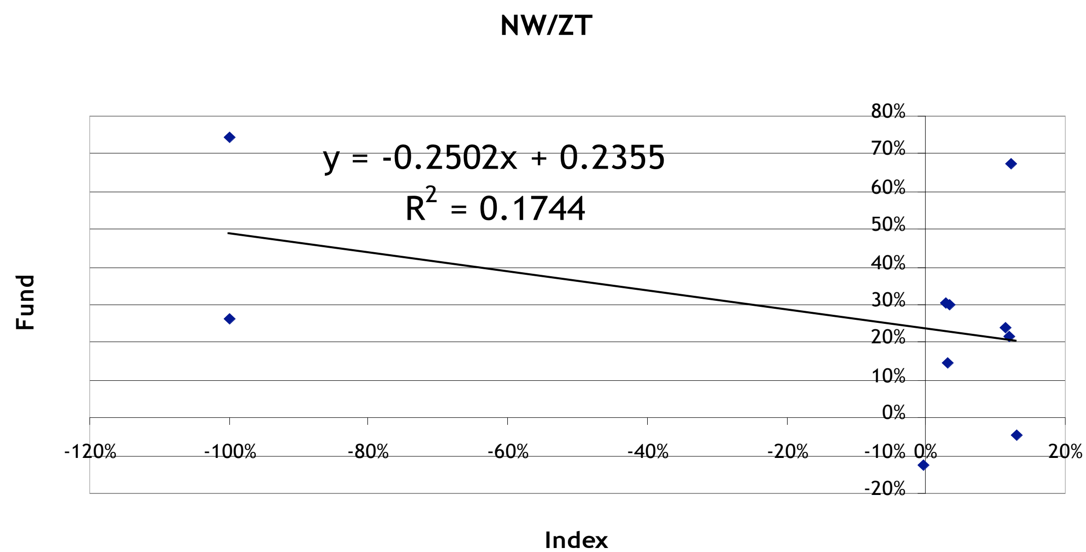
Another interesting and powerful way to apply OCOM plot analysis and NWTZ performance attribution is to use them to screen fund deal flow. When used as a screening tool in this way, the data points on the OCOM plot represent individual investment transactions within a fund and/or individual investment funds within a manager's track record.

For example, beginning with an example manager with an extensive track record, the fund-based OCOM plot is as follows:

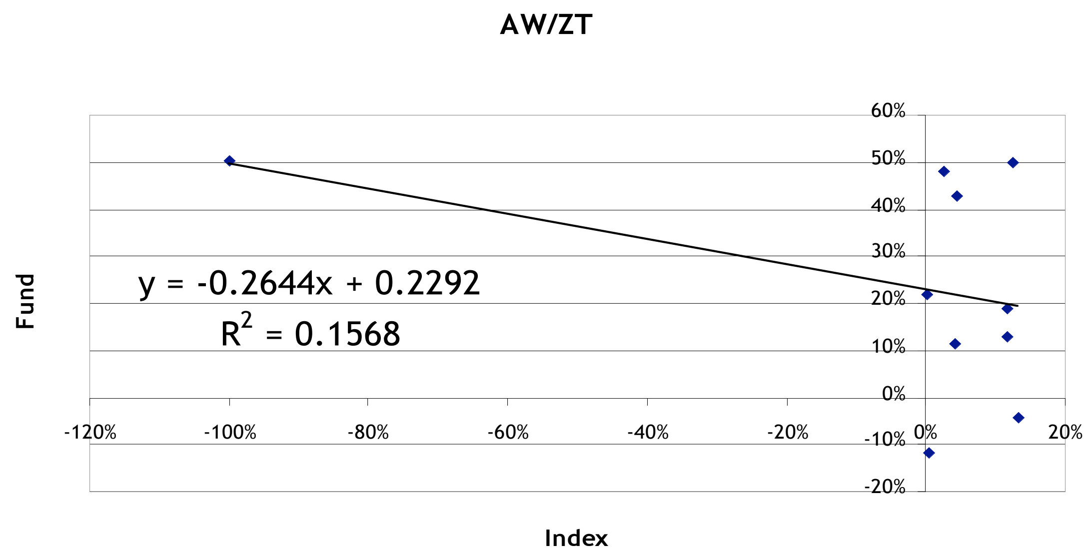


Note that this fund-based OCOM plot has one plot point that shows a -100% return to the index. As noted above, very large distributions from a private investment transaction, fund or vintage can result in a negative (i.e., short) position in the index. In this case, a linear regression that includes the extremely successful fund's plot point results in a beta for the entire track record that is near zero.

When the same track record uses the neutral-weight, zero-time cash flows of the base portfolio, there are two plot points with -100% returns to the index:



Finally, the actual-weight, zero-time cash flows result in the following OCOM plot:

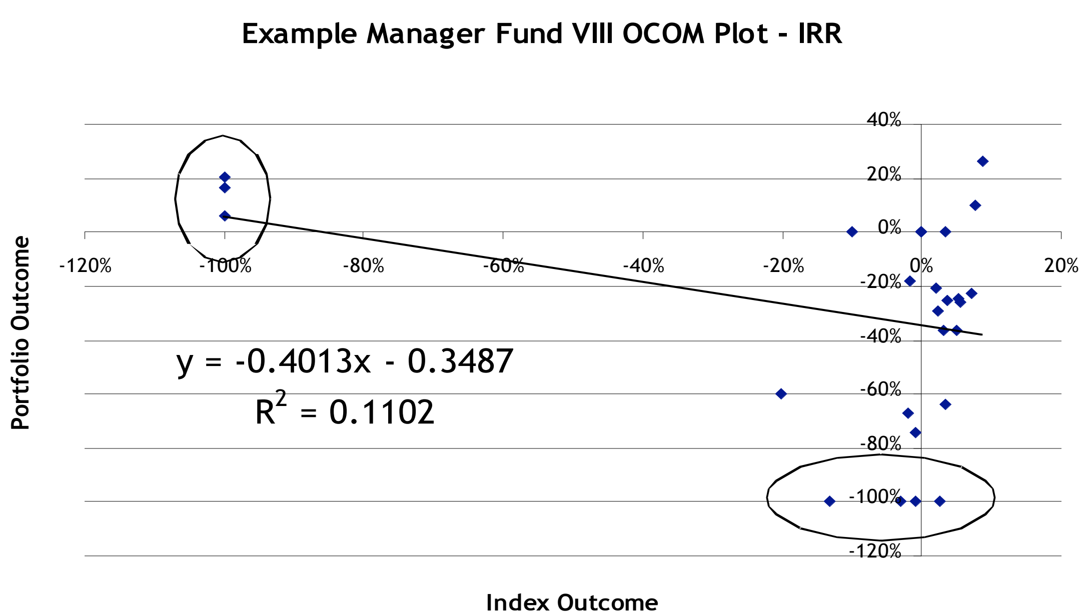


Applying NWZT performance attribution analysis to the above OCOM plots, we obtain the following:

		beta	alpha
	I (NW/ZT)	-0.2502	0.2355
	II (AW/ZT)	-0.2644	0.2292
	IV (AW/AT)	-0.0075	0.217
I	Base Portfolio	-0.2502	0.2355
II - I	Selection	-0.0142	-0.0063
IV - II	Timing	0.2569	-0.0122
IV	Actual	-0.0075	0.217
II + I	Controllable	-0.2644	0.2292

You can interpret this result to mean that the beta due to the timing of the funds in the track record (.2569) was almost exactly offset by the negative beta of the base portfolio (-.2502). The result was therefore almost completely uncorrelated with the investment outcomes of the index. The alpha of the track record, on the other hand, originated almost entirely with the base portfolio. This is a very strong result that indicates excellent deal flow.

As noted above, vintages tend to be less variable (i.e., less risky in terms of investment outcomes) than funds. It should come as no surprise that funds are less risky than individual transactions. Put another way, OCOM plots based on transactions are usually much more distorted by a very wide range of investment returns and opportunity cost (ICM) returns than OCOM plots based on funds or vintages. The following OCOM plot, for example, contains plot points that represent individual investments within a single fund:



The circled transactions in the upper left of the graph above were so successful as to drive the index negative and result in a -100% IRR. The circled transactions in the lower right of the graph above lost all the capital invested. This OCOM plot illustrates the dichotomy between extreme success (the upper left) and extreme failure (the lower right) typical of venture capital as a sub-asset class.

When we compute the public market risk/return profile of each of the funds, we obtain the following:

			S&P 500 arithmetic mean	**0.0677**	
			S&P 500 sigma	**0.1358**	
			Sharpe ratio		**0.4987**
	beta	alpha	R squared	σ	Sharpe
Fund I	-0.432	0.248	0.001	2.074	0.106
Fund II	6.016	0.108	0.211	1.781	0.289
Fund III	4.959	-1.176	0.162	1.672	-0.502
Fund IV	-0.281	0.033	0.028	0.227	0.060
Fund V	-1.203	0.377	0.515	0.228	1.299
Fund VI	-0.381	0.388	0.027	0.312	1.159
Fund VII	0.704	-0.012	0.256	0.189	0.191
Fund VIII	-0.401	-0.349	0.110	0.164	-2.289
Fund IX	-24.634	2.065	0.326	5.865	0.068
Fund X	4.641	0.152	0.100	1.994	0.234

Notice that the investment efficiency of Fund VIII, the OCOM plot of which is shown as an example above, is the worst in the entire track record. Note also that when the OCOM analysis is done at the track record level by fund, its efficiency soars. This is a direct result of the diversification to be expected from a grouping of funds, each of which is composed of numerous portfolio companies.

You can use the OCOM plot, together with NWTZ performance attribution, to help you select funds with a superior risk/return/correlation profile. Over time, this should enable you to diversify your portfolio, decreasing its risk while maintaining or increasing its return. You can also use the OCOM and NWTZ to understand the risks of your existing portfolio and, by selectively including and excluding funds, you can understand the effect of a potential secondary purchase or sale on your overall risk position.

Intellectual Property Rights in OCOM Plot Analysis

The OCOM plot analysis of private equity risk and correlation with the public market that is discussed in this paper is the subject of U.S. patent 7,421,407, which is the property of Alignment Capital Group, LLC. This publication is intended solely for research purposes. For further information, please log onto www.alignmentcapital.com.