HOW MANY EGGS? HOW MANY BASKETS?

Factors that Inform Optimal Diversification in a Multi-Manager Portfolio

Strategic Investment Group®

Fiduciary Insights

IN THIS FIDUCIARY INSIGHT, WE ADDRESS THE QUESTION OF DIVERSIFICATION IN A MULTI-MANAGER PORTFOLIO AND SPECIFICALLY, WHAT THE RIGHT NUMBER OF MANAGERS IS. How can an investor decide whether there are too many or too few managers in their portfolio, and is there such a thing as over-diversification? We introduce a framework for analyzing this issue and the important factors to consider.

Introduction

We have often been asked how to optimally generate alpha or excess return through manager selection so that a portfolio is not overly concentrated nor overly diversified. This paper analyzes the topic of diversification of active risk within a multi-manager portfolio. We also present a framework for rigorously examining the ideal number of investment managers to whom capital should be allocated. In the process, we address the "over-diversification" fallacy of portfolio construction that alpha diversifies away. Our key conclusions are:

- ***Contrary to conventional wisdom, there is no implied inverse correlation between the number of managers in a portfolio and alpha potential.*** This generally accepted theory is based on several mistaken premises, namely that decreasing active risk always lowers alpha potential, that an increasing number of manager bets can "cancel each other out," and that there are only a small number of excellent managers.
- ***Although more diversification reduces active risk, it does not necessarily reduce alpha potential.*** Optimal diversification in a multi-manager portfolio also depends on the skill and research capacity of the investment team, the overall alpha potential of the client's investment universe, and the correlation among the target managers.
- ***The manager selection capacity of the investment team directly impacts alpha and risk.*** Every investment team has a finite capacity to identify, research, and select excellent managers. If other factors are the same, including investment skill, a higher capacity investment team can generate higher alpha and lower active risk.
- ***An investment universe with greater expected alpha allows for more managers.*** Expected alpha varies across investment universes of asset classes and strategies. The number of managers in a portfolio (diversification) should increase along with expected alpha for that asset class.
- ***Lower correlation between managers can further improve diversification without reducing alpha.*** Adding high performing managers to a portfolio that have low or negative correlation to each other lowers active risk while preserving alpha.
- ***Passive investments can play a role in eliminating over-diversification.*** Over-diversification can be measured as the point at which a portfolio would have higher alpha and lower active risk by replacing some active managers with a passive investment.
- ***Investor preferences are a key consideration in portfolio diversification.*** A detailed understanding of the investment process and the investor's preferences is required to make any decision about the diversification of the portfolio.

Optimal diversification in a multi-manager portfolio also depends on the skill and research capacity of the investment team, the overall alpha potential of the client's investment universe, and the correlation among the target managers.

Background

Institutional investors typically hold portfolios of investments with many external investment managers, providing exposure to different asset classes, market segments, and styles. A recurring question is how many managers should be in a portfolio, especially when they are within the same market segment. When should an investor conclude that there are too many or too few, and can we find an optimal number? We tackle this question in two parts:

First, we challenge the commonly held belief that, as the number of managers in a portfolio increases and active risk decreases, the potential for alpha is also necessarily reduced.[1] We argue that this misconception is based on several mistaken assumptions and that measuring active risk or active share alone is not sufficient to determine the ideal number of managers.

Second, we identify factors that are important in determining the number of managers that should be in a portfolio. We show that evaluating these factors depends on a detailed understanding of both the investment process and the investor's preferences, not just a review of portfolio characteristics.

[1] Appendix A provides definitions of certain terms like active risk and alpha.

As more managers are added to a portfolio, the active risk will tend to decline as the portfolio becomes more diversified. Based on this effect, many investors intuitively conclude that the portfolio's return also must become closer to that of the benchmark, which implies lower alpha. This reasoning is incorrect, both logically and mathematically.

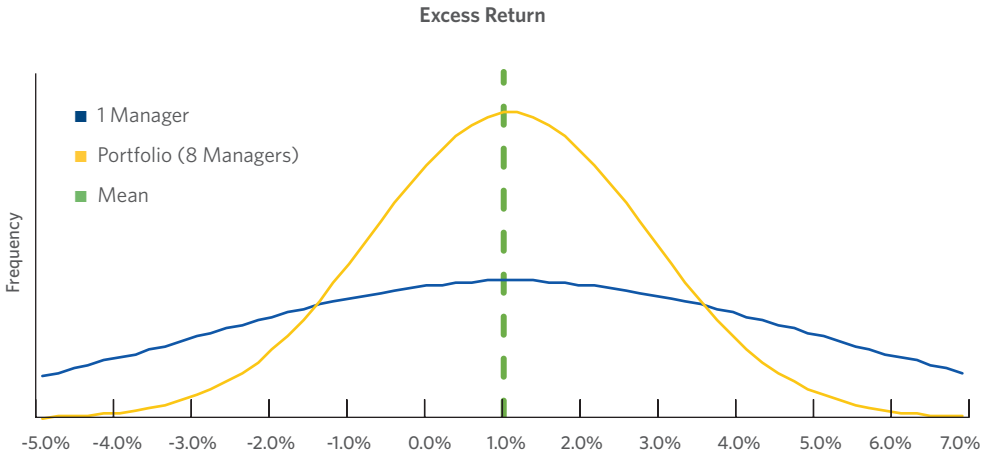
Underlying this analysis are a couple of important assumptions. We believe that active management, when executed by a skilled investment team using a well-designed process, can be very beneficial for an institution. Although we touch on some factors important for generating alpha in this paper, our focus here is on diversification, and we assume that the investment team in the examples can generate positive alpha over the long term.[2] In addition, we assume that most investors prefer lower active risk to higher if everything else, including total alpha and total return, is the same. In other words, if two portfolios generate the same return and alpha over the long run, the investor would prefer the one with more consistent alpha, which is another way of saying lower active risk.

Part I. Misconceptions of "Over-diversification"

One common misconception is that low active risk means low alpha potential. As more managers are added to a portfolio, the active risk will tend to decline as the portfolio becomes more diversified. Based on this effect, many investors intuitively conclude that the portfolio's return also must become closer to that of the benchmark, which implies lower alpha. This reasoning is incorrect, both logically and mathematically. If this were true, the performance of such a portfolio could be improved by splitting the portfolio in two (putting half the managers into one bucket and half into another), thereby raising the active risk of both new portfolios. According to this logic, both portfolios would outperform the original, which is clearly impossible. In fact, low active risk only implies more consistent alpha, not lower average alpha. The alpha of a portfolio of managers will always be the average alpha of those managers regardless of the active risk of the portfolio.

A graphical representation of this concept is shown in Exhibit 1 which illustrates how reducing active risk through diversification can be achieved while maintaining the same level of alpha. It shows the frequency distribution of the alpha of one manager and a portfolio of eight similar managers. Each manager in this example has an annualized alpha of 1%. As we go from one manager to eight (the blue line and the gold line respectively), the alpha distribution narrows as the active risk goes down. However, note that the mean of the gold graph is the same at 1% expected alpha as the mean of the blue graph. Over the long term, the alpha in the two portfolios will be the same. The risk diversifies away. The alpha does not diversify away.

EXHIBIT 1:
Source: Strategic.



[2] A more comprehensive discussion of active management and the factors necessary to generate outperformance is addressed in a forthcoming paper.

Another misconception is that as managers are added to a portfolio their underlying positions may cancel each other out and this will hurt performance. Using equities as an example, one manager may be overweight a stock by 2% and another may be underweight the same stock by 2%. When the two managers are combined in a portfolio, the portfolio will hold a benchmark weight in that stock. The overweight and underweight will have cancelled each other out. On the other hand, if both managers are overweight the same stock by 2%, the portfolio will be overweight by 2% as well, but the portfolio will never have a larger weight in that stock than the managers. It will always be equal to or lower than the weight the managers hold. This causes the portfolio to look more and more like the broad market as managers are added. The combined portfolio will have a lower active share than the managers themselves. The concern is that, in the extreme, the portfolio becomes an "expensive index fund" as the investor pays active management fees but gets an index fund.

How can we reconcile this issue with the principle that alpha is conserved when alpha-producing managers are combined in a portfolio? The answer is that the combined portfolio will tend to have a higher number of profitable positions than the managers that make up the portfolio. For example, if there are two managers in a portfolio, assuming both have positive alpha, the positions that cancel out are more likely to be losers than the positions they hold in common. The combined portfolio will have smaller over weights and lower active share, but the active positions held will tend to be more profitable. This is how alpha is preserved even as the combined portfolio starts to look more like the broad market. The concern about positions canceling out is a complete red herring. Similarly, active share for the portfolio of managers is irrelevant to alpha.[3]

Another misconception is that there are very few excellent managers so any portfolio that has too many managers is bound to be made up of mediocre managers and will likely underperform. There is a big difference, though, between the idea that it is hard to find excellent managers and the idea that there are very few excellent managers. If we use equities as an example, the universe of institutional managers is huge. In the eVestment database in 2017 there were almost 6,000 active large cap equity strategies, including U.S., international, and global. Over the next 5 years over 1,100 outperformed their benchmarks by over 2% per year. For other asset classes including fixed-income, hedge funds, and private equity, the number of institutional managers is similarly large. We find that for most asset classes the universe of managers is not a constraint on the potential number of managers in a portfolio. If an investor has the skill to find one or two high performing

Another misconception is that as managers are added to a portfolio their underlying positions may cancel each other out and this will hurt performance.

EXHIBIT 2:

Source: eVestment.

[3] This is true even if active share is important in selecting individual managers. An investor who prefers high active share managers should not focus on the active share of their total portfolio.

Assuming the investor has skill in choosing managers, the expected alpha of the next manager chosen will tend to be lower than that of the existing managers. On the other hand, adding managers reduces the active risk of the portfolio. This is the key source of the trade-off between alpha and risk.

managers, then it seems likely that, with sufficient time and resources, they could find, say, eight or ten. The key, though, is the skill, time, and resources, which are clearly limited. This points to the importance of the capacity of the investor to effectively evaluate managers. This capacity is one of the main factors determining the ideal number of managers in a portfolio as we will show in Part 2.

Part 2. A Framework for Multi-Manager Portfolios

In this section we identify broad principles and types of analysis that can guide an investor in striking the balance between active risk and alpha. We find there are four main factors that are important in determining the number of managers that should be in a portfolio. They are:

- *Capacity of the Investment Team:* The capacity of the investment team determines the number of managers they can effectively research, select, and monitor without impacting alpha.
- *Differentiation:* The lower the correlation among managers, the greater the benefit from diversification. Lower correlation should result in a larger number of managers in the portfolio.
- *Expected alpha:* In market segments with higher expected alpha, the portfolio should have more managers.
- *Active risk*: Is the portfolio active risk acceptable for the investor? An investor may prefer lower or higher active risk which could result in a different portfolio.

In Part 1 we constructed a portfolio assuming all managers had the same expected alpha. However, when we change that assumption and allow the expected alpha to vary among managers, the expected alpha will tend to decline as more managers are added to the portfolio. This is because the investor will tend to choose their highest-ranked manager first, then their second-favorite and so on. Assuming the investor has skill in choosing managers, the expected alpha of the next manager chosen will tend to be lower than that of the existing managers. On the other hand, adding managers reduces the active risk of the portfolio. This is the key source of the trade-off between alpha and risk.

Exhibit 3 illustrates this effect with what we call the alpha line which shows the relationship between the hypothetical investor's ranking of a manager and the subsequent alpha of that manager. Here each

EXHIBIT 3:
Source: Strategic.

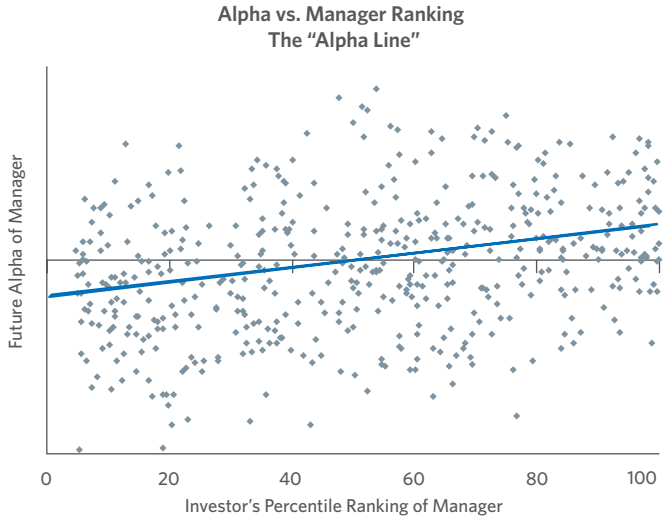
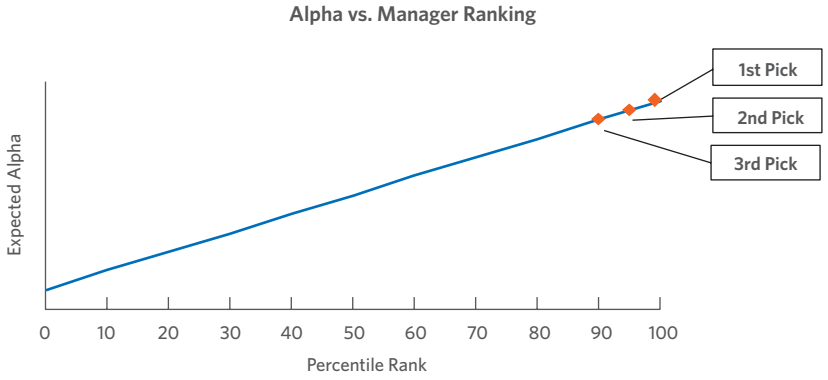


EXHIBIT 4:
Source: Strategic.

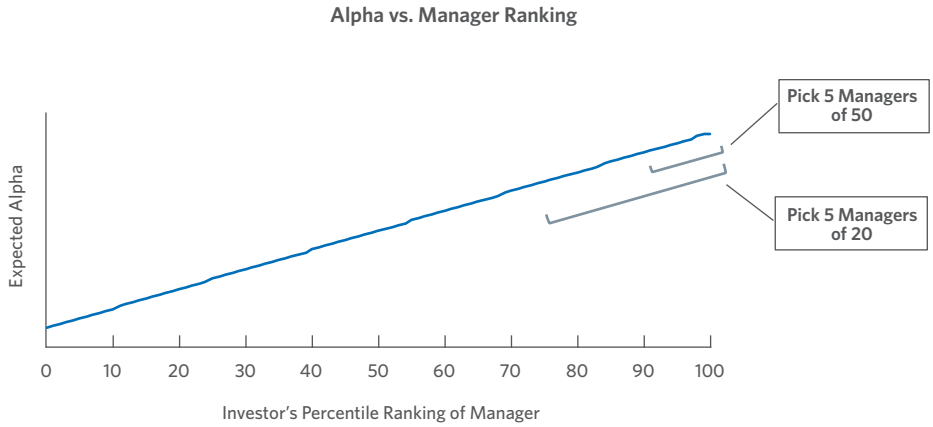


dot represents a manager that the investment team has researched and ranked. The vertical axis is the subsequent alpha of that manager.[4] The blue line is a regression through the data points. Note that the slope of the regression line is a measure of the investment team's skill at picking managers, with a steeper slope indicating more skill. In this example, the investment team has skill as managers ranked highly tend to have higher alpha than those with low ranks, although there is significant variation for any individual pick. The level of the regression line is related to the prevalence of alpha in the universe of managers. In this example, the average manager generates no alpha which can be seen by the line crossing 0 alpha at the 50th percentile. This represents an efficient market segment where alpha is not readily available to institutional investors.

In this framework, when the investor is building their portfolio, they will start with the highest ranked manager and move down in ranking as they add more managers as shown in Exhibit 4. Portfolios with more managers will have a lower average expected alpha than portfolios with fewer managers. In practice, the difference in expected alpha from one pick to the next is often negligible. Most investors will tend to evaluate managers in broad categories rather than make fine distinctions between each one in terms of expected alpha. However, the direction is clear in that at some point the next manager added will be of lower quality than the others.

The expected alpha of the portfolio will depend, not only on the alpha line, but also on the size of the manager pool the investor is selecting from. Note that this is the number of managers the investor has researched and effectively evaluated, not the total universe of

EXHIBIT 5:
Source: Strategic.



[4] Note these data are simulated.

available managers. We use the term "managers covered" to refer to this number. This number relates to the capacity of the investor or the investment team. If the investor, for example, picks five managers for their portfolio, they will start with their highest ranked manager and then move down their list. However, whether they are picking their top 5 out of a pool of 20 or out of 50 will make a difference in expected performance as shown in Exhibit 5.[5] on page 5.

The number of managers covered clearly can affect performance, but our primary consideration here is its effect on the desired number of managers in a portfolio. Simply, the more managers an investor can research and evaluate effectively, the more managers can be in the portfolio without giving up performance.

Next, we move from individual managers to a portfolio of managers. Exhibits 6 and 7 show how expected alpha and active risk will decline for portfolios with more managers. As managers are added, alpha will fall steadily while active risk will fall rapidly at first then more slowly as the marginal benefit from diversification declines. One way to measure the trade-off between alpha and active risk is

EXHIBIT 6:
Source: Strategic.

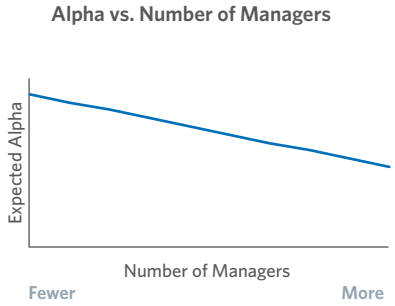
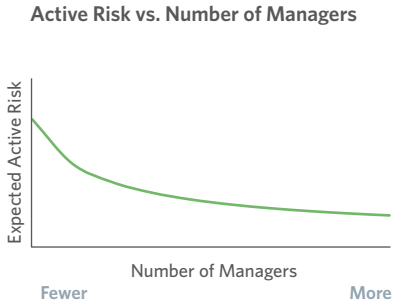


EXHIBIT 7:
Source: Strategic.



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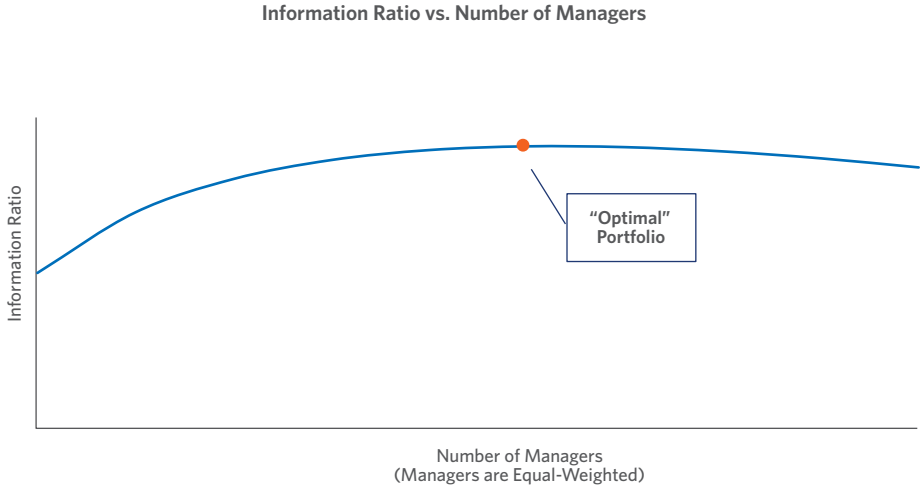


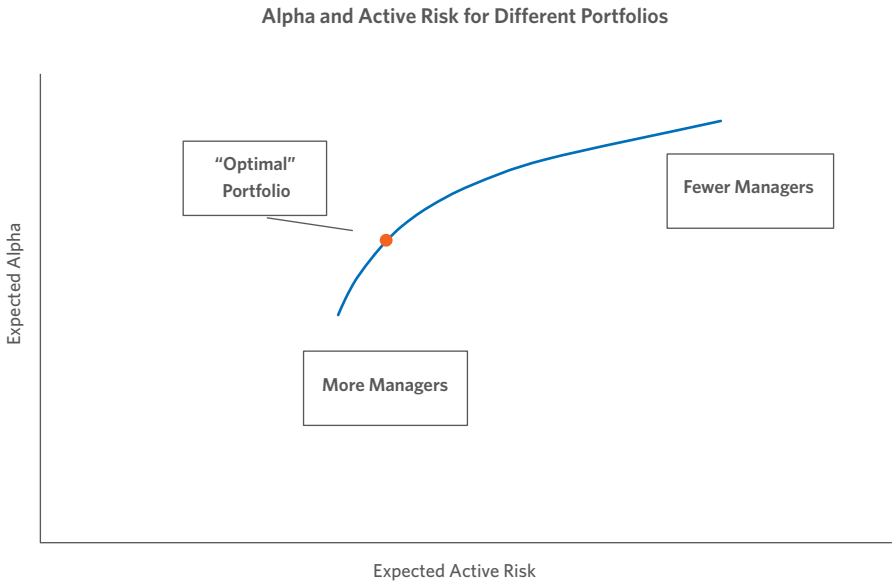
[5] This is a highly simplified description of how a typical institutional investor chooses managers for a portfolio. In practice, the process is usually on-going rather than a single decision. In addition, other considerations besides expected alpha play a role, including the specific risks and exposures a given manager brings to the portfolio. These factors make the process more complex in practice. However, we find that they do not change the broad conclusions from our framework.

with the information ratio, which is the ratio of the excess return divided by active risk and is shown in Exhibit 8. In the example shown, the information ratio rises at first, reaches a maximum, and then begins to decline as more managers are added. The portfolio with the highest information ratio is labeled "optimal" in the chart. As the information ratio rises, the alpha will become more consistent. For example, a portfolio with an information ratio of 0.4 will tend to outperform in 2 years out of 3, while an information ratio of 1 will result in outperformance of about 5 years out of 6. The diversification of the portfolio will affect both the magnitude of any underperformance and the long-term alpha as well as the consistency of that alpha from year to year. Note that the "optimal" portfolio in the chart is not necessarily the ideal portfolio for a given investor, but we will see that it is still an important concept for portfolio construction.[6]

We can combine the alpha and active risk charts into a single chart which shows the same information in a different format as shown in Exhibit 9. Here, active risk is on the x-axis and alpha is on the y-axis. Each point on the line represents a portfolio with a different number of managers. The point labeled "optimal" is the same portfolio as the one noted in the information ratio chart (Exhibit 8). This format is analogous to the CAPM efficient frontier, except instead of relating total return to total risk, it relates relative return (alpha) to relative risk (active risk). We can see when going from a portfolio with one manager (the upper right end of the blue line) to many managers (the lower left), both alpha and active risk decline although the trade-off becomes more acute as more managers are added. The shape and placement of this line will primarily be determined by three factors: 1) the number of managers "covered" by the investment team, 2) the alpha line, and 3) the correlation among the managers. Note that these are three of the four main factors from page 4. Changes in one or more of these factors will move the line and will tend to change the optimal portfolio. We will show this next.

We can see when going from a portfolio with one manager (the upper right end of the blue line) to many managers (the lower left), both alpha and active risk decline although the trade-off becomes more acute as more managers are added.

EXHIBIT 9:
Source: Strategic.



[6] The "optimal" portfolio would be ideal only if the investor is primarily interested in maximizing the likelihood of outperformance without considering the magnitude of alpha. Even in that case, if the portfolio in question is a subset of the total portfolio, the ideal portfolio will probably not be the "optimal" one.

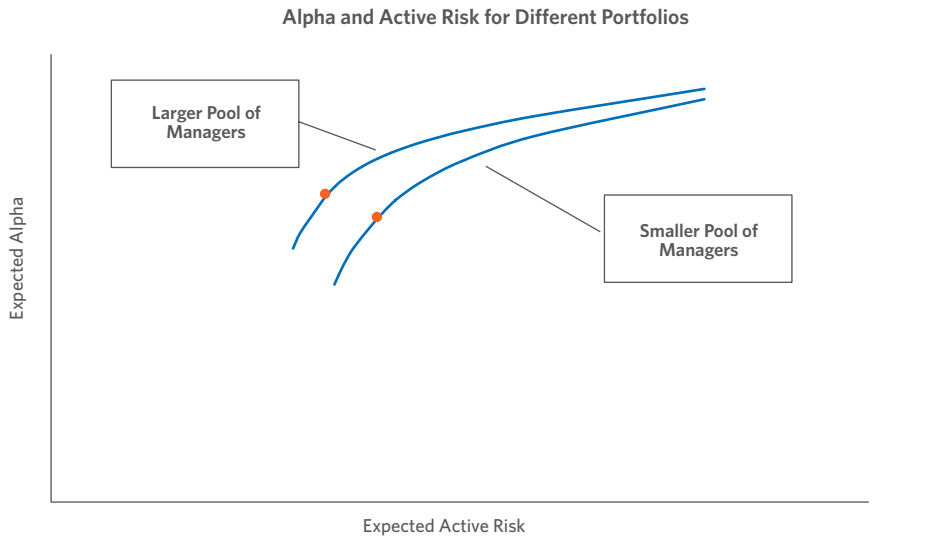
As expected, an investment team with more capacity can manage a more diversified portfolio without giving up alpha. Also, note that increasing the number of managers in the pool allows for portfolios that have both higher expected alpha and lower expected active risk.

To see the effect of the capacity of the investment team on the portfolio, we can increase the number of managers "covered". This would require the investment team to spend more resources researching managers. Increasing this number moves the line up and to the left as shown in Exhibit 10. Note how the optimal portfolio, marked with the orange points on the graph, will shift down and to the left indicating a portfolio with more managers. As expected, an investment team with more capacity can manage a more diversified portfolio without giving up alpha. Also, note that increasing the number of managers in the pool allows for portfolios that have both higher expected alpha and lower expected active risk. It is important to note, however, that we are holding everything else constant in this example, including the investment team's skill. In practice, a larger investment team with more capacity would only get this result if their skill was the same as that of the smaller team's skill.

Like the Exhibit 10 example, when we change either the alpha expectations or the expected correlation among managers, the line in the example chart will shift. Shifting the line will affect not only the expected alpha and active risk but also the "optimal" number of managers in the portfolio. We show more examples of this effect in Appendix C.

So far, we have only considered active managers as investment choices. Next, we will consider adding a passive investment to the portfolio. The gold line in Exhibit 11 shows the effect of adding a passive investment to the "optimal" portfolio. Again, we can see the analogy with CAPM where in this case the passive investment plays the role of cash in CAPM allowing an investor to efficiently control risk. If an investor decides that the active risk of their portfolio is too high, they can add managers to increase diversification moving to the left along the blue line. However, when they go beyond the diversification of the "optimal" portfolio, they would be better off adding passive rather than diversifying more. This is the point at which a portfolio becomes over-diversified. We can see this visually as the gold line is above the blue line when moving to the left of the "optimal" portfolio, implying higher alpha for a given amount of active risk. The dotted gold line to the right of the "optimal" portfolio represents an optimal portfolio that is levered and hedged with a short position in passive. In theory, using leverage in this way is the most efficient way to boost alpha. In practice, though, this may be infeasible for most investors.

EXHIBIT 10:
Source: Strategic.



Having outlined a framework for the diversification of a portfolio, we can identify several key principles. We see that more managers will tend to lower both active risk and expected alpha. The levels of and trade-off between these two characteristics will depend primarily on the three factors discussed: **the capacity of the investment team**, **the alpha line**, and **the correlation among the managers**. These will determine the "optimal" portfolio, which maximizes the information ratio. If a portfolio has more managers than the "optimal", it is overdiversified, and the investor would be better off reducing the number of managers and adding a passive investment. Importantly, one cannot judge whether a portfolio is overdiversified simply from statistics like the number of managers, active risk, active share, and so on. Instead, the ideal number of managers is based on the characteristics of the investment process and the given market segment.

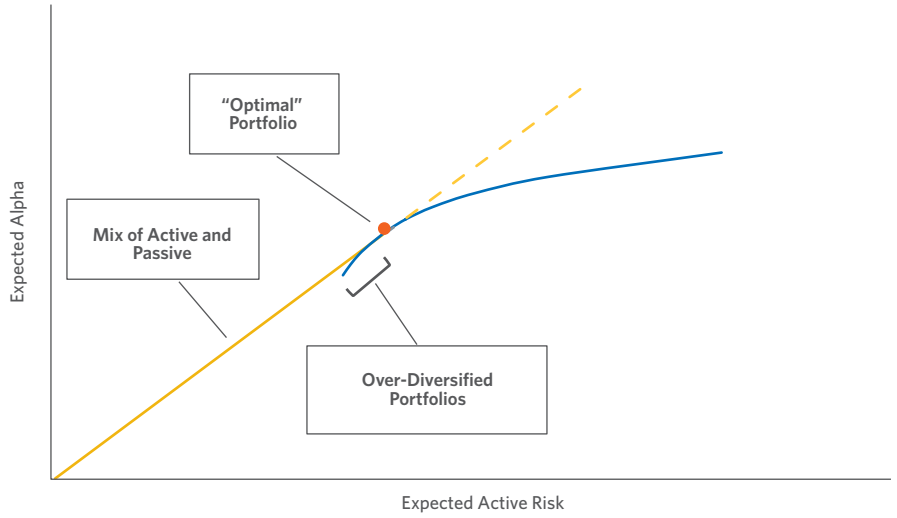
The last consideration, which we have not addressed in detail, is the preferences of the investor. This will determine where along the blue, or gold, line in Exhibit 11 the ideal portfolio should be. An in-depth discussion of how an investor should make this decision is beyond the scope of this paper, but we will note a few points here. First, if a portfolio has fewer managers and higher active risk, any underperformance (or outperformance) will be larger, but the frequency of underperformance will also increase. This is because the information ratio generally declines as the number of managers declines. An investor with a more concentrated portfolio has to be prepared for more frequent and long-lasting periods of underperformance, not just larger amounts of underperformance. In addition, an investor's tolerance for higher active risk and a lower information ratio is not the same as an investor's tolerance for total risk, although the two may be related. Finally, we have shown this framework in an idealized and precise way. However, in practice, this process is approximate as estimating any of these parameters is very difficult. The benefits of this approach come from considering the broad principles to follow when establishing an investment process and building a portfolio.

One cannot judge whether a portfolio is over-diversified simply from statistics like the number of managers, active risk, active share, and so on. Instead, the ideal number of managers is based on the characteristics of the investment process and the given market segment.

EXHIBIT 11:

Source: Strategic.

Alpha and Active Risk for Different Portfolios



Appendix A. Glossary

Active Risk: The standard deviation of the excess return, also called tracking error.
Active Share: The sum of all over-weighted positions in a portfolio relative to a benchmark. This is a measure that is used to estimate how active a manager is relative to their benchmark.
Alpha: The excess return adjusted for the difference in risk between a portfolio and the benchmark. We use alpha interchangeably with excess return in this paper.
CAPM: Capital Asset Pricing Model. A financial model that estimates the expected return of an investment based on its riskiness relative to the rest of the market.
Excess Return: The difference between a portfolio's return and the benchmark's return.
Information Ratio: The excess return divided by the active risk. This is a measure of the consistency of outperformance of a portfolio.
Manager: We use the term manager to refer to a single active strategy or fund, in contrast to an investment management firm which may manage multiple strategies.

Appendix B. Theoretical Considerations

Here we provide a more detailed discussion of the theory behind our framework. A good starting point is *The Fundamental Law of Active Management*, as outlined by Grinold and Kahn.[7] The Fundamental Law is defined by this equation:

$$IR = IC \times \sqrt{Breadth}$$

Here IR is the information ratio. IC is the information coefficient, which is the correlation of the investor's forecast and the subsequent return of the investment. The IC is a measure of the skill of the investor. Breadth is the number of independent investment decisions the investor makes. We can also separate the components of IR to rewrite the equation:

$$\text{Excess Return} / \text{Tracking Error} = IC \times \sqrt{Breadth}$$

The Fundamental Law was conceived to describe an active manager who picks individual securities. In this case we are using it to describe an institutional investor who picks managers. IC, then, relates to the investor's skill at evaluating managers, and breadth relates to the number of managers in a portfolio.

One of the key differences between our framework and that of other researchers is that others implicitly or explicitly assume that the skill of the investor is defined by the information ratio. They may assume, for example, that an investor should expect a set IR for their portfolio regardless of the number of managers. If that is the case, then certainly as the portfolio becomes more diversified and the tracking error declines, the alpha has to decline too and decline at the same rate as the tracking error. In our framework by contrast, we separate the skill of the investor from the breadth of the portfolio. We use what we call the alpha line, which is similar to IC in The Fundamental Law, to define the skill of the investor (as well as the alpha opportunity in the asset class). We then consider the breadth of the portfolio to be a separate decision by the investor, primarily how many managers to put in the portfolio.

With this approach, which more accurately describes a typical investment process, we can see that IR is not fixed and will tend to change depending on the number of managers in the portfolio, generally rising as more managers are added. However, there is no free lunch, and as breadth increases, the expected alpha of the portfolio will start to decline as the investor will have to eventually pick lower rated managers. The rate at which alpha declines depends on both the alpha line and the capacity of the investor, but the rate does not depend on the tracking

[7] *Active Portfolio Management*, 1999.

error of the portfolio. With this approach, we link both the tracking error and alpha of the portfolio to the number of managers in the portfolio. We also point out the impact of the correlation among the managers. In the second equation on page 10, breadth is not actually the number of managers in the portfolio, it is the number of independent investment decisions. If the managers chosen are correlated, then the breadth of the portfolio will be lower than the number of managers. As a result, lower correlation among the managers will result in higher breadth and higher IR.

Appendix C. Alpha and Correlation

EXHIBIT 12:
Source: Strategic.

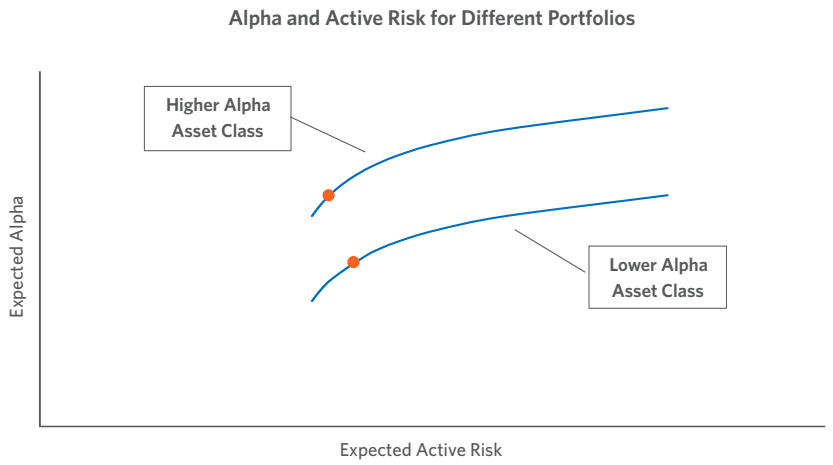
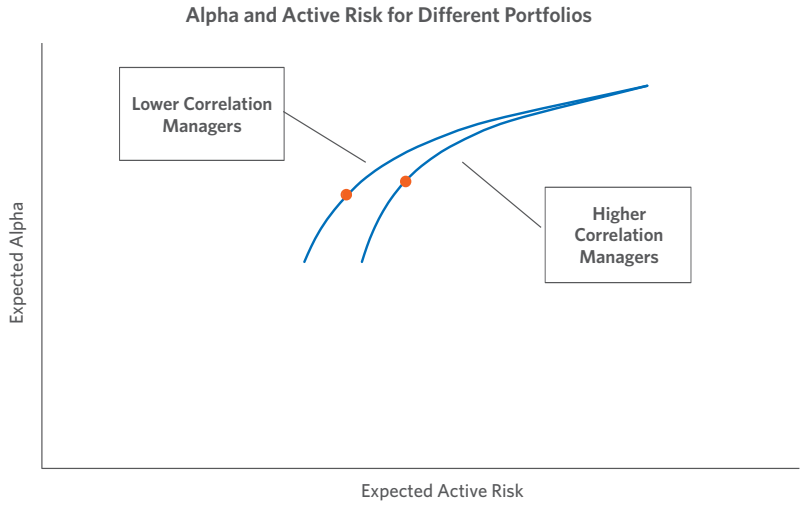


Exhibit 12 shows the effect of changing the alpha assumption. In some asset classes or market segments institutional managers may generate positive alpha on average. The upper line shows the risk / alpha trade-off for an asset class where the average alpha is higher. This will tend to result in an "optimal" portfolio with more managers. With more alpha, the investor can increase diversification. Similarly, when the managers have lower correlation, the "optimal" portfolio will also be more diversified as shown in Exhibit 13. Intuitively, if the managers are similar, there is less advantage from diversification, and the portfolio is better off with fewer managers.

EXHIBIT 13:
Sources: Strategic.



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Strategic, a pioneer in dedicated Outsourced CIO (OCIO) solutions since 1987, offers a comprehensive service platform for managing customized portfolios for institutional and private investors. Our proprietary process combines active portfolio management, rigorous risk management, and open architecture manager selection.

Strategic functions as our clients' investment partner and co-fiduciary, effectively becoming an extension of their resources. Clients are then free to focus on their core businesses, while we focus on providing the highly specialized portfolio management expertise that clients need to meet their investment goals. Depending on a client's needs and preferences, Strategic can orchestrate the management of an entire portfolio comprising multiple asset classes, focus on specific asset classes, such as alternatives (e.g., venture capital/private equity, real estate, and/or hedge funds) or international investments, or manage strategies with high potential for adding value. Customized liability-driven investing (LDI) solutions, whether through an integrated total portfolio approach or a targeted long-duration strategy, are also available, as are solutions that address mission-related investment objectives.

We strive to build enduring partnerships with our clients by strengthening their investment programs through a dynamic, value-enhancing investment process, sound governance framework, and world class client service. Our mission is to empower investors through experience, innovation, and excellence.

For more information, please email us at inquiries@strategicgroup.com.

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