A successful investment process requires a risk management structure that addresses multiple aspects of risk. Here we lay out a best practices framework that rests on three pillars: Risk Measurement, Risk Monitoring, and Risk-Adjusted Investment Management. All three are critical. Risk Measurement means using the right tools accurately to quantify risk from various perspectives. Risk Monitoring means tracking the output from the tools and flagging anomalies on a regular and timely basis. Risk-Adjusted Investment Management (RAIM) uses the information from Measurement and Monitoring to align the portfolio with expectations and risk tolerance.

Introduction

The last 18 months have brought risk management to the forefront and highlighted the need for guidance on best practices for investors. Many institutional investors were surprised by the violent market moves during the current crisis. Some have argued that current risk management practices failed when they were needed most, and with multi-sigma events extending across formerly uncorrelated asset classes, investors have questioned the very meaning of the term "well diversified portfolio." What does sound risk management mean for plans, foundations, endowments, and other institutional investors? How should these institutions think about best practices in risk management? We start with three guiding principles:

1. “Risk management is not limited to the risk manager. Anyone involved in the investment process, from the CIO to the portfolio managers, should be thinking about risk.” Risk management should not be limited to an after-the-fact reporting function but must be woven into the investor's decision-making process, whether it is the asset allocation decision or the process for hiring managers. Those responsible for asset allocation and management should be risk managers at heart and consider risk and return tradeoffs before making investment decisions.

2. “If you can’t assess the risk of an asset, maybe you shouldn’t invest in it.” For those institutions invested in alternative asset classes, such as private equity and hedge funds, or who have exposure to complex instruments, such as derivatives and structured products, the risk management requirements have greatly increased. These investors need a framework for managing risk that far exceeds what was needed for the plain vanilla stock and bond investing that prevailed only ten years ago. We argue that one should assess one's risk management capabilities before making the decision to invest in certain asset types.

3. “Proactive risk management is better than reactive risk management.” Being prepared for unlikely events is perhaps the most important lesson learned from the recent crisis. This applies to both market risk and nonmarket risks such as counterparty, operational, leverage, and liquidity. Addressing this issue transcends the simple use of the output of models and tools. It requires an institutional mindset that analyzes the global economic outlook, understands the aggregate portfolio exposures across asset classes, and is willing to use the model output intelligently to align the portfolio structure with the plan sponsor's assessment of the risks that may impact the portfolio.
In this paper, we propose a risk management framework that:

- Is aligned with the investment objectives and investment horizon
- Tackles multiple aspects of risk and is not limited to a single measure like Tracking Error or Value at Risk
- Measures, monitors, and manages exposures to economic and fundamental drivers of risk and return across asset classes to avoid overexposures to any one risk factor
- Manages risk for normal times but is cognizant of and aims to be prepared for extreme events

We developed this framework with institutional investors and their risk management challenges in mind, but this framework can be adapted easily to the requirements of asset managers. In the first section of the paper, we describe a framework that takes into account the three guiding principles. In the second section of the paper, we illustrate this framework in more detail and provide examples for its implementation.

I. Three Pillars for Risk Management

Our goal is to establish sound market risk management principles for institutional investors. We rely on three pillars: Risk Measurement, Monitoring, and Management (or Risk-Adjusted Investment Management, RAIM). Risk Measurement refers to the tools institutional investors use to measure risk. Risk Monitoring focuses on the process of evaluating changes in portfolio risk over time. RAIM refers to how investors may adjust their portfolios in response to expected changes in risk. Robust risk management integrates all three areas.

Exhibit 1: The Three Pillars of Risk Management

The risk manager's toolkit may include a variety of measures capturing different views of risk. Exhibit 2 illustrates one way to categorize the suite of tools needed. We distinguish between risk measures for normal and extreme times as well as risk measures that relate to absolute losses or losses relative to a benchmark.

On one hand, institutional investors need to manage the total risk of their investments, which means protecting themselves from asset-liability deficits, declines in broad asset classes, and more generally, any losses large enough to make it difficult to meet the investor's obligations. On the other hand, institutions need to manage the risk of managers underperforming their benchmarks, which involves monitoring the tracking error and performance relative to the assigned benchmark.
Exhibit 2: Structure for Risk Measurement and Monitoring

### Alpha (Active Risk)
- Normal
  - Tracking Error
  - Contribution to Tracking Error
  - Active Exposures
  - Benchmark Misfit

- Extreme
  - Stress Testing
  - Active Bets
  - Active Contribution to Tail Risk
  - Maximum Active Drawdown

### Beta (Total Risk)
- Normal
  - Asset Class Volatility / Beta
  - Contributions to Total Risk
  - Sources of Return / Exposures

- Extreme
  - Stress Testing
  - Asset Classes
  - Total Contribution to Tail Risk
  - Max. Drawdown, Contagion Effect

To assess future risks, it is essential to measure and monitor risk both at the aggregate level and at the factor level. For risk measurement, most institutional investors measure aggregate portfolio risk with volatility or tracking error, which rely on individual volatilities and correlations of asset classes and managers. However, while volatility, tracking error, and correlations capture the overall risk of the portfolio, they do not distinguish between the sources of risk, which may include market risk, sector risk, credit risk, and interest rate risk, to name a few. For instance, energy stocks are likely to be sensitive to oil prices, and BBB corporate bonds are likely to be sensitive to credit spreads. An analysis of the sources of risk requires portfolio decomposition along various characteristics or exposures via a factor model.¹ Institutional investors can use portfolio decomposition to understand how much return and risk from different asset classes or managers resulted from prescribed factor exposures in the past,² or how much risk to expect going forward.

Risk Monitoring enables institutions to monitor changes in the sources of risk on a regular and timely basis. For instance, many well diversified US plans saw a growing exposure to financial sector, housing, and credit risk from 2005-2006. While risk managers may not have foreseen a looming correction, the ability to monitor these exposures would have at least alerted them to the risks in the event of a correction.

Portfolio decomposition plays an important role in stress testing. Here, the sources of risk are stressed by the risk manager to assess the impact on the portfolio. Stress testing is flexible in enabling risk managers to gauge the impact of an event on the portfolio. The stress scenario might be real or hypothetical, commonplace or rare, but stress tests are used typically to assess the impact of large and rare events. Scenarios can come in different flavors, such as macro shocks, market shocks, or factor shocks.

¹ The Barra Integrated Model (BIM) is such a multi-asset class model for forecasting the asset- and portfolio-level risk of global multi-asset class portfolios or plans. The model begins with a detailed analysis of individual assets from 56 equity markets and 46 fixed income markets to uncover the factors that drive their risk and return. The assets, both equity and fixed income, together with commodities, hedge funds, and currencies, are then combined into a single risk model. This makes it suitable for a wide range of investment purposes, from conducting an in-depth analysis of a single-country portfolio to understanding the risk profile of a broad set of international investments across several asset classes.

² Performance attribution, i.e., the attribution of realized returns to a set of exposures times factor returns, can provide valuable insight to risk managers seeking to identify where their investments or managers added value. In addition, it can highlight similarities between asset groups or managers' strategies in a way that is far more informative than looking at historical inter-manager correlations alone.
The intuition behind stress testing for market risk can be applied to nonmarket or systemic risks, such as leverage and liquidity risk. When leverage and liquidity shocks occur, as in 2008, it may result in unexpected increases in investment commitments for which no immediate funding source is available. While largely unpredictable, the impact of such shocks can be analyzed using stress tests. Exhibit 3 lists a number of stress test categories that investors might employ on a regular basis to assess the immediate impact on the portfolio as well as the change in impact over time.

Exhibit 3: Stress Tests Uncover Possible Weaknesses in the Portfolio

I. Systemic Shock
   - Liquidity shock
   - Leverage shock

II. Macro Shock
   - Interest rate shock
   - Oil price shock

III. Marketwide Shock
   - Marketwide Decline in Equity Prices

IV. Targeted Shock
   - U.S. Value Stocks Hit
   - Japan Growth Stocks Hit

Our discussion of stress testing segues naturally into the problem of managing tail risk, or the risk of some rare event occurring. Whereas stress tests do not address the likelihood of extreme shocks occurring, other methods for analyzing tail risk do. This recent period of turmoil has acutely highlighted both the importance of managing tail risk and the inadequacy of generic tail risk measures, such as parametric Value at Risk.

While the simplest measure of Value at Risk (parametric VaR) assumes that returns are normally distributed, more sophisticated methods for calculating Value at Risk do not. These span a wide range of modeling choices that may rely on parametrically or non-parametrically specified non-normal distributions, or Extreme Value Theory. For a more detailed discussion on the latter, we refer to Barbieri et al (2009) and Goldberg et al (2009). Other measures of tail risk, such as Expected Shortfall (Conditional VaR) and Maximum Drawdown, seek to capture a different and potentially more relevant facet of tail risk. In general, turbulent times highlight the need for monitoring appropriate tail risk measures. Such times also call for the frequent reporting of exceptional developments, i.e., reporting that highlights unusual changes in risk measures or increases in exposure to certain factors.

Before we move on to the third pillar, Risk-Adjusted Investment Management, it is important to point out that Risk Monitoring requires the necessary IT and infrastructure resources for support. First, accurate data is essential, as is sufficient coverage of the assets held in the portfolio. Delays in a risk manager’s ability to view changes in holdings, prices, or characteristics are often caused by infrastructure limitations. In some cases, data may not be readily available, or the resources required to collect data from custodians or individual managers may be prohibitively expensive. In addition, hard-to-model assets, such as complex derivatives, hedge funds, and private equity, can pose a challenge for even the most advanced systems. In sum, institutions

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4 Value at Risk captures the expected loss at some threshold, while Expected Shortfall captures the expected loss once that threshold has been exceeded. Maximum drawdown is defined as the largest drop from a peak to a bottom in a certain period.
should consider the costs of implementing the necessary risk management systems when they
decide in which assets to invest.

One consequence of the current crisis may be that investors become more cautious when they
choose their investments. Warren Buffett, for example, commented at his recent shareholder
meeting on complex calculations used to value purchases: “If you need to use a computer or a
calculator to make the calculation, you shouldn't buy it.” Even though that statement may be
extreme, the point is well taken. The damage that exotic, illiquid, and hard-to-value instruments
have triggered over the last 18 months highlighted the need to be able to assess the risks of
investments before money is allocated to such investments.

The third pillar in our framework is Risk-Adjusted Investment Management (RAIM), which puts
risk measurement and monitoring outputs into action. While risk measurement provides the
measures, and risk monitoring ensures that the measures are timely and relevant, without the
ability to make adjustments to the portfolio, this information is of limited value for protecting the
investor against losses. RAIM aligns the investment decision-making process with the risk
management function. For instance, RAIM might be used to make portfolio adjustments as either
the correlations between assets or managers rise or the probability of certain tail risk or disaster
scenarios increases. RAIM could also facilitate the management of risks coming from certain
sources of return, or it could aid in better diversifying the portfolio. Specifically, RAIM could be
used in the development of overlay strategies that would facilitate certain hedges, e.g., currency
hedges, or tail risk insurance.

As an example, the declines in the broad equity market last year caused many pension plans to
become underfunded. Decision-makers may decide that their tolerance for losses should be
limited to a specific percentage. They should then decide whether that limit should be maintained
through a passive hedge or through a trigger mechanism defined by the breach of clearly defined
parameters of a risk measure. Some pension plans started hedging their equity exposure to limit
downside risk, though for many it was too late. One reason why pension plans may not have
hedged their market exposure more frequently is the cost of hedging. Hedging reduces the
performance of the portfolio in up markets, but in periods when the market declines, hedging
limits the downside. Exhibit 4 illustrates a successful market hedge that includes a stop-loss plan
at a point when assets drop below a specified level.

Exhibit 4: Risk-Adjusted Investment Management to Protect against Downside Risk
All three pillars – Risk Measurement, Risk Monitoring, and RAIM – are indispensable to a complete risk management structure. Exhibit 5 summarizes the three pillars, illustrated with specific examples. The chart uses the same idea we presented before, namely, that risk measures can be categorized by normal and extreme times and relative versus absolute investment objectives.

Exhibit 5: Three Pillars of Risk Management

II. Implementing a Market Risk Management Framework

In practice, the needs of institutional investors can be wide ranging, and their ideal measurement, monitoring, and managing capabilities will differ. In this section, we illustrate the case of a hypothetical but typical US plan sponsor. Although there may be additional criteria, the three critical drivers of risk management requirements are shown in Exhibit 6.

Exhibit 6: What Drives the Risk Management Requirements?
(1) **Return Requirements**: The plan’s liabilities or expected payouts will influence not only the assets in which it invests but also which benchmarks are used and how much it can lose over certain periods. The latter, in turn, may drive how much risk it is willing to take and with how much exposure to certain sources of return/risk it is comfortable.

(2) **Investment Horizon**: The plan’s investment horizon, or willingness to sustain shorter-term shocks, will influence which risk measures are appropriate and how frequently they need to be monitored.

(3) **Complexity of Investments**: Plans that invest in difficult-to-value assets with potentially non-normal return distributions or unusually high exposure to tail events require additional risk measures, higher monitoring frequencies, and advanced RAIM capabilities.

These criteria are naturally linked, although the degree of importance might vary from plan to plan. For instance, return requirements may play the primary role in driving the choice of instruments and asset classes for some plans, while they may play a less important role for other plans. For some plans, the investment horizon is tied directly to their return requirements, while for others, it is more a function of how much they are willing to lose over a given period. Regardless, these three criteria determine the guiding principles for any plan’s risk management function.

For example, a plan sponsor with reasonable and relatively infrequent payout obligations, a large surplus, and with limited exposure to alternatives and complex instruments does not need short-term measures or frequent monitoring. This plan would benefit from focusing on longer-term risk measures. Instead of setting up a system to calculate 10-day Value at Risk measures, the plan could focus on how multiyear regime shifts in different risk factors, such as interest rate cycles, may affect the portfolio’s value.

In contrast, a plan with frequent and significant expected payouts, a limited ability to sustain short-term losses, and with substantial exposure to alternatives and complex instruments would require a wide variety of risk measures, frequent risk monitoring, and a well developed RAIM process. Most plans are likely to fall between these two extremes.

Another example may help to shed light on these ideas. In Exhibit 7, we group investors into one of three categories using the third criteria – complexity of instruments and asset classes.

**Exhibit 7: Plan Types Depending on Investments in Various Asset Classes/Instruments**

<table>
<thead>
<tr>
<th>Type 1</th>
<th>Type 2</th>
<th>Type 3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Simple Equity / Bond allocation</strong></td>
<td><strong>Small allocation to Alternatives</strong></td>
<td><strong>Significant investment in Alternatives (&gt;10% of Portfolio)</strong></td>
</tr>
<tr>
<td>No complex Derivatives or Alternatives</td>
<td><strong>Limited exposure to complex instruments</strong></td>
<td><strong>Significant exposure to complex instruments</strong></td>
</tr>
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</table>

A Type-1 plan invests in a straightforward allocation to equities and fixed income. Equity and fixed income allocations may be limited to the domestic market, and fixed income investments are mostly concentrated in government bonds and AAA-rated corporate. A Type-2 plan may invest in equities globally, including emerging markets. Fixed income investments may include high yield bonds and mortgage-backed securities, and the plan may also invest in alternatives and complex...
derivatives. However, as a percentage of the plan’s total value, the investments in alternatives and derivatives would be small. A Type-3 plan would invest in a variety of alternative asset classes as well as complex instruments but to a larger extent than Type-2 plans.

Currently, the vast majority of pension plans fall into the second group. We therefore consider a hypothetical Type-2 plan for our illustration of a risk management framework. Its asset allocation is shown in Exhibit 8.

**Exhibit 8: Example of a Type-2 US Plan**

<table>
<thead>
<tr>
<th>Asset Class</th>
<th>Weight</th>
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<tbody>
<tr>
<td>Equity</td>
<td>60%</td>
</tr>
<tr>
<td>- US</td>
<td>36%</td>
</tr>
<tr>
<td>- International</td>
<td>24%</td>
</tr>
<tr>
<td>Fixed Income (US)</td>
<td>25%</td>
</tr>
<tr>
<td>Alternatives</td>
<td>15%</td>
</tr>
<tr>
<td>- Real Estate</td>
<td>5%</td>
</tr>
<tr>
<td>- Private Equity</td>
<td>5%</td>
</tr>
<tr>
<td>- Hedge Funds</td>
<td>5%</td>
</tr>
</tbody>
</table>

A first critical step is to adopt tools that enable the plan to measure and monitor risk at the source, or factor level, and not just at the aggregate level. The plan should then monitor its exposure to different risk sources on a regular basis - monthly or quarterly at the very least. This would occur at the total portfolio level, looking across asset classes. In addition, the plan can require from its managers more detailed information on risk exposures. Many plans receive only high-level performance summaries focusing on realized returns and tracking error. Requiring estimates of exposures to various sources of risk is a crucial extension. For illustration, we show how this would fit in the framework we have used so far:

**Total Risk:**

- **Normal Periods:** The plan can evaluate sources of return and risk across its overall portfolio using a multi-asset class factor model. Sources of risk can include macroeconomic and market factors. An example of the type of analysis that can be done is to look at the performance of the plan’s portfolio in different macroeconomic regimes. The plan could then adjust its asset allocation during the next review period.

- **Extreme Events:** Using the sources of risk for the overall portfolio, the plan can shock certain factors or sources of risk, i.e., those likely to suffer in the event of a market dislocation, including a systemic meltdown or series of external shocks. These stress tests would enable the plan to evaluate how individual or multiple simultaneous shocks impact the overall portfolio (i.e., tail risk and tail correlations). The plan could then establish an action plan if asset values drop by some absolute or relative (e.g., to liabilities) amount.

**Active Risk:**

- **Normal Periods:** The plan can ask for reports on their sources of risk from all equity, fixed income, and alternatives managers, or the plan can estimate them internally. Sources of active risk should be detailed and focused on the specific risk and return drivers of the manager’s investment strategy. For instance, analyzing a value, small cap
equity manager's tracking error will focus on the active bets relative to the agreed upon benchmark, ideally a small cap value benchmark like the MSCI Small Cap Value Index. Measuring and monitoring will focus on questions of active bets relative to this benchmark, e.g., does the manager’s portfolio have a consistent small cap value bias or did the portfolio move towards growth-oriented companies over the last few years when value stocks underperformed? The active risk analysis should ensure that the hired manager is following his or her mandate and is not deviating from the agreed upon guidelines.

- **Extreme Events:** The plan may want to stress test the impact of the joint underperformance of a number of active strategies that historically have been uncorrelated. For example, during the quant meltdown in August 2007, a number of return factors became suddenly highly correlated, leading to severe negative portfolio performance relative to their respective benchmarks. Such stress tests enable the plan to evaluate how shocks impact an entire group of managers. Other useful measures for rare events are tail risk and tail risk correlations of active bets across managers. Certain factors or strategies may become highly correlated across asset classes or markets during crises (e.g., value or momentum across equity markets) and could lead to vastly higher losses relative to their respective benchmarks than estimated by the tracking error.

The above examples illustrate how a model that decomposes risk along its sources can help institutions evaluate different types of risk across different dimensions. It can be applied similarly to realized returns in order to attribute past performance. For our hypothetical Type-2 plan, a suggested set of minimum components for risk management may include:

- Aggregate measures of volatility and tracking error across managers and asset classes
- An accurate decomposition of return and risk across asset classes, utilizing an integrated (across asset classes) multi-factor risk model
- A stress testing framework and/or extreme risk measures for understanding tail risk and tail risk correlations in the portfolio
- An appropriate set of benchmarks

The exact measures, monitoring frequencies, and RAIM processes the plan adopts will depend on its return requirements and expected payouts, and its investment horizon and willingness to tolerate short-term losses. For instance, a plan with limited ability to withstand short-term losses may want to build out its ability to assess tail risk over different horizons using risk measures such as Expected Shortfall based on Extreme Value Theory, which is more conservative than parametric Value at Risk. These plans may also want to implement extensive stress tests across asset classes and within certain subcategories of investments. Meanwhile, plans with greater ability to withstand short-term losses may opt for more basic tail risk measures and stress tests.

Our example focused on a Type-2 plan. For a Type-3 plan, this illustration would also be relevant, but the requirements for measuring, monitoring, and managing different types and sources of risk would be more extensive. For a Type-1 plan, the extent to which it invests in risk management should depend on its liabilities structure and its short-term risk tolerance.

Most plans, regardless of their specific characteristics, can take some basic actions on an organizational or administrative level to manage risk. Our hypothetical plan may establish a risk committee consisting of the CIO, risk managers, senior portfolio managers, and legal and compliance officers that meets at least once a quarter to discuss the overall economic and financial environment. Participants can discuss their concerns regarding systemic risk issues such as liquidity and leverage, review the results of stress tests, and debate whether hedging

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strategies should be activated to address undesired exposures or potential tail risk events. The plan could also develop a reporting framework where the risk committee would receive at least monthly reports on unusual developments identified by the risk manager. Then, if the investment committee is sufficiently concerned about exposure to a certain segment, it could ask those managers with large exposures to hedge them or to eliminate the undesired exposures.

Exhibit 9 illustrates this type of setup, where the risk manager prepares risk reports and recommendations for the risk committee and deliverers risk management services and advice to the different asset class managers.

**Exhibit 9: Organizational Structure for Risk Management**

Finally, the plan may establish minimum risk management requirements for external managers. For instance, the external managers could be required to demonstrate their ability to calculate tracking error, Value at Risk, or other measures, as well as how risk management impacts their portfolio construction.

**Conclusion**

Recent events have put into stark relief the inadequacy of the current state of risk management. Much has been said about the need for better risk management and a greater degree of risk awareness in the broader investment community. Risk management is a dynamic area, and any set of best practices are bound to evolve over time. Here we set out to clarify some of the principles and tools that we believe are required for a sound risk management framework.

Specifically, we lay out a framework that rests on three pillars—risk measurement, monitoring, and RAIM (or Risk-Adjusted Investment Management). Each of the three domains is critical for risk management. Risk measurement means having the right tools to measure risk accurately from various perspectives. Risk monitoring means observing the risk measures on a regular and timely basis. Risk-Adjusted Investment Management means using the information from the measurement and monitoring layers intelligently to ensure that the portfolio management process is aligned with expectations of risk and risk tolerance.

While each pillar encompasses a different aspect of risk management, each is indispensable to a strong risk management process. Moreover, they are interdependent and should be aligned with the investor’s objectives. Their interconnectedness drives the key conceptual theme—that risk management and the investment process should be fully integrated.
Contact Information

clientservice@mscibarra.com

Americas

<table>
<thead>
<tr>
<th>City</th>
<th>Phone Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Americas</td>
<td>1.888.588.4567 (toll free)</td>
</tr>
<tr>
<td>Atlanta</td>
<td>+ 1.404.551.3212</td>
</tr>
<tr>
<td>Boston</td>
<td>+ 1.617.532.0920</td>
</tr>
<tr>
<td>Chicago</td>
<td>+ 1.312.675.0545</td>
</tr>
<tr>
<td>Montreal</td>
<td>+ 1.514.847.7506</td>
</tr>
<tr>
<td>New York</td>
<td>+ 1.212.804.3901</td>
</tr>
<tr>
<td>San Francisco</td>
<td>+ 1.415.576.2323</td>
</tr>
<tr>
<td>Sao Paulo</td>
<td>+ 55.11.3706.1360</td>
</tr>
<tr>
<td>Stamford</td>
<td>+1.203.325.5630</td>
</tr>
<tr>
<td>Toronto</td>
<td>+ 1.416.628.1007</td>
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Europe, Middle East & Africa

<table>
<thead>
<tr>
<th>City</th>
<th>Phone Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amsterdam</td>
<td>+ 31.20.462.1382</td>
</tr>
<tr>
<td>Cape Town</td>
<td>+ 27.21.673.0100</td>
</tr>
<tr>
<td>Frankfurt</td>
<td>+ 49.69.133.859.00</td>
</tr>
<tr>
<td>Geneva</td>
<td>+ 41.22.817.9777</td>
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<td>London</td>
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<td>Madrid</td>
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<tr>
<td>Milan</td>
<td>+ 39.02.5849.0415</td>
</tr>
<tr>
<td>Paris</td>
<td>0800.91.59.17 (toll free)</td>
</tr>
<tr>
<td>Zurich</td>
<td>+ 41.44.220.9300</td>
</tr>
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Asia Pacific

<table>
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<tr>
<th>City</th>
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<tbody>
<tr>
<td>China Netcom</td>
<td>10800.852.1032 (toll free)</td>
</tr>
<tr>
<td>China Telecom</td>
<td>10800.152.1032 (toll free)</td>
</tr>
<tr>
<td>Hong Kong</td>
<td>+ 852.2844.9333</td>
</tr>
<tr>
<td>Singapore</td>
<td>+ 65.6834.6777</td>
</tr>
<tr>
<td>Sydney</td>
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</tr>
<tr>
<td>Tokyo</td>
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The company’s flagship products are the MSCI International Equity Indices, which include over 120,000 indices calculated daily across more than 70 countries, and the Barra risk models and portfolio analytics, which cover 56 equity and 46 fixed income markets. MSCI Barra is headquartered in New York, with research and commercial offices around the world.