September 2020

Building a Risk Culture at UC Investments

Jagdeep Singh Bachher, Chief Investment Officer

Rick Bookstaber, Chief Risk Officer

Paramount among the 10 pillars that underpin the UC Investments Way is "Risk Rules," which embodies a forward-looking approach to risk management we call Risk 3.0. This means that at UC Investments, we are all risk managers. Each investment opportunity is viewed through a risk lens.

Risk 3.0 is the product of our collaboration over the past five years. It started with new tools taken from complexity theory to help understand the dynamics of future risk and gauge how a given market scenario might cascade and propagate. Its implementation goes beyond this to understand and address risk's often overlooked dimensions. And its final destination is the creation of a UC Investments risk culture.

Dimensions of Risk

Risk is human.

As humans, we are subject to nature's capricious course, but much uncertainty is of our own making. Our tastes and interests are fickle. We build financial instruments that introduce new risks and transform existing risks. We induce instability and tensions in the political realm. We change the world and thus the components of risk as we innovate and create. Likewise, we alter risk when our growing experience leads us to respond to similar events in different ways.

For example, the world was changing as the 2008 financial crisis approached because of innovations in credit default swaps and sub-prime mortgages. It has changed since through the proliferation of Exchange Traded Funds (ETFs) in illiquid markets such as high yield bonds and emerging markets, the ongoing trend toward passive and factor-based investing,

and the reduction in liquidity due to post-2008 effects of the Volcker Rule. Most recently it has changed through an assertive new Federal Reserve policy that in a flash turned fixed income markets from being liquid to the point of near-failure. With each of these changes, the nature of market risk changed as well.

Risk is long-term.

As the inventor Charles Kittering said, "We should all be concerned about the future, because will have to spend the rest of our lives there." We need a mindset and technology that accommodates this unerring truth. And because the markets discount now for events in the future, some of the long-term issues will manifest as risks in the shorter-term. For example, the most severe outcomes from climate change might not be realized for decades, but prices will rapidly readjust once the market wakes up to these long-term effects.

Pensions and endowments, and indeed all asset owners, are hampered by standard risk management tools borrowed from other financial services that were designed for short time horizons. Risk management tools were developed in the early 1990s for banks and broker-dealers to manage inventories with holding periods of days. In the 2000s, they found their way into hedge funds, which manage speculative positions that turn over in a matter of months. The short time frame of the standard models comes from one characteristic – one could say flaw – that has persisted since they were introduced nearly 30 years ago: they measure risk only by looking at the past. Typically they look at the variability of returns over the past one or two years to assess risk going forward.

Risk in the next few days or months might generally be similar to the risk over the past year or so (although, unfortunately, not when it really matters.) But however well the standard risk models work for the short term, they are not appropriate for our mission. In contrast to the focus of banks and hedge funds, the time horizon of UC's pension is measured in lifetimes. Indeed, our focus at the University of California is on what we call "Centennial Performance," the last of our 10 investment pillars. The University of California has been around for more than 150 years, and we must look at risks going out just as far. That is a difficult task, but certainly as a start we must think beyond the next few months.

We have to realize the world will change, that the markets as we see them today – much less as they might evolve in the future – are not what they were in the past.

Risk is dynamic**.**

When it comes to risk management, the standard model anticipates that risk in the future will look like risk in the past. Even the most sophisticated risk systems estimate forward risk based on the volatility over the past few years.

At UC Investments, we call this historically focused approach Risk 1.0, which is fixed and static. Not only is risk historically based, it is compressed into two simple metrics: volatility and correlation. There is none of the waxing and waning caused by volatility and market trends, nor the "fat tails" that come from shifts in the business cycle and investor zeitgeist.

The Risk 1.0 approach extends to using standard what-if exercises of stress testing and scenario analysis, what we call Risk 2.0. These, too, are executed through a historical lens, either explicitly by looking at times in the past where similar events occurred, or by applying the historical relationships between the markets when projecting how a scenario might unfold.

The past will not repeat, even if an identical shock occurs in the future. The market today is not the market of the past. Leverage and liquidity are different. There are new strategies, and an emphasis on new instruments. Regulation and fiscal and central bank policy shift. Having learned from past experiences, investors will engage with the markets differently.

And scenarios of any weight have second acts. They create market cascades and propagate to other markets, and do so in different directions and through different channels from one event to the next. In stress scenarios, Risk 2.0 is static in a dynamic world; it does not think to ask: "And after that, what next?"

Unlike what Risk 1.0 and Risk 2.0 offer, at UC Investments we demand risk management that is dynamically oriented to a possible future, that can help navigate the future path of risk, and that understands and respects, but is not beholden to, the past.

This is not to say we ignore history, nor do we discount the measure of effectiveness of the standard models. History can be a guide on a day-to-day basis, but when risk really matters the failures of Risk 1.0 are self-evident, largely because the markets are occupied by humans, not machines. If we attempt to measure what is dynamic and ever-changing with a fixed and static model, we will be wrong.

Addressing Market Risk: The Risk 3.0 Solution

We model risk as a complex dynamical system.

For addressing the dynamic nature of risk, we adopted the modeling framework of Risk 3.0 and technology that accommodates complex and ever-changing market dynamics. The key tool in formalizing the way we think about market risk is agent-based modeling. Agent-based models are a form of structured machine learning used to treat problems complicated by the fact that human decision-makers are involved. These models have uses ranging from understanding traffic congestion to anticipating potential stampedes from panicking crowds. So, not surprisingly, they find an application with markets, too.

In the investment markets, the agents range from investors to traders, market makers to funders. Some agents (a.k.a. humans) act quickly based on recent price momentum; others act more slowly and adjust based on deviations from an asset allocation goal. Some take on leverage and de-lever rapidly in the face of market shocks that push them close to the margin ceilings of their funders. Step by step, the various market participants look at the market environment and act, and their actions in turn change the market, leading to new actions in response.

The agent-based model looks at the world as it is today. It does not rely solely on the history of prices. It recognizes that the market today might differ from that of the past, with different instruments and strategies being employed in a different part of the market cycle

by investors with differing market views. It reflects the current features of the market, such as leverage, liquidity, and market concentration. An exposition of what is missing in standard risk models and how risk models based on agent-based methods overcome those limitations is the topic of Rick Bookstaber's book, *The End of Theory* (Princeton University Press, 2017).

We communicate and team up.

Successful risk management requires investment professionals "Team Up," another of UC Investments' pillars. It is difficult to get a full view of risk if equity investment professionals are talking about basis risk and volatility while those in fixed income are talking about duration and credit spread widening. At UC Investments, we have mandated an official "risk language," and have risk measures and firm-wide risk reporting in that language. And, of course, all professionals need fluency in the same language; they need to understand risk in those terms.

We meld the human with the machine.

"Human Meets Machine," another of our pillars, takes in the human dimension of risk. Think of Human Meets Machine as part technology – perhaps artificial intelligence and machine learning – and part human experience and insight. While we are able to mimic key aspects of human intelligence and reasoning with artificial intelligence, we know that we must temper what we expect from technology. We balance technology with human judgment, experience, and expertise.

We understand that even the sophisticated dynamic simulations of agent-based models can only compute risks that have an attentive precedent. The risks we create as humans do not always fit this mold. Our current challenges – from the existential risk of climate change, to the global rise of populism and authoritarian regimes, to the deadly coronavirus pandemic – are risks that numbers in a monthly risk report cannot sum up. They require that even the most powerful models be matched with human understanding and sense of the human condition in order to create a complete risk narrative.

We control risk by concentrating it.

Another of our key pillars germane to Risk 3.0 is "Concentrate." From a return standpoint, holding a wide set of positions inevitably leads to mimicking the market. Any edge disappears. From a risk standpoint, the diversification benefit that comes from this is a chimera. Warren Buffett once remarked, "Wide diversification is only required when investors do not understand what they are doing." The purpose of Risk 3.0 is, of course, to fully understand the risks one is taking.

To this dictum might be added, "Diversification is only useful when it is not needed." When the markets move into a high-risk regime, all risky assets become correlated. The subtleties of relative earnings and other comparative factors no longer matter. It is all risk, and it all trades similarly.

Yet the standard risk systems and any optimization program bolted onto them push a portfolio to many holdings. This is because these programs do not understand the nature of risk, and the computers that run them are indifferent to doing calculations across a hundred positions versus a hundred thousand. They interpret the world presented through the variance-covariance matrix of historical returns as unerringly true. But of course correlations are only approximate, change over time, and often are without logic. Should Chilean credit really be correlated with Icelandic equities? According to the correlation matrix behind the standard model, it should.

We know what we own.

Position transparency is an obvious prerequisite for discussions of portfolio risks. Many organizations don't invest directly in understanding what they own and instead rely on their custodian bank to maintain a list of all assets. That information is usually lagged a quarter, at least for private illiquid assets. It is difficult to see positions in real time, and when faced with large risks in the markets we need to know what we own now.

When we started on our path toward increased transparency, we had no centralized database of all the assets, companies, and financial instruments we owned. The first step

was to have our partner firms give us transparency on what assets they held in as close to real time as possible. They had not been providing this information for the simple reason that we had not asked for it. So we embarked on selecting a risk system and asked our external investment partners for transparency. Many were uncomfortable with our request and declined to comply. Because managing our overall, and specific, risk was a priority, we asked for our assets back and moved on. By 2019 we were in a comfortable place with about 85% transparency. We continue to progress from there.

Another facet in gaining transparency was paring down the number of partners we worked with. This reduced the number of companies we owned, and increased alignment with our partners. By eliminating partners who were duplicating or triplicating risks we were taking, we became more concentrated and more effectively diversified versus over-diversified. In public equities we went from 60 partners to 15 partners and from 8,000 stocks to 800 stocks. And most important, we knew what we owned because the list was more manageable. In the 2020 crisis, we let our partners in public equities keep doing what they do. We knew how they were positioned, and this helped calm nerves as we watched the market free fall for 19 days and drop in value by 34%.

Internal alignment was also key, as exemplified by the joint effort of Jagdeep, Rick, and UC Investment's chief operating officer, Arthur Guimarães, to further transparency by incorporating position data into our risk system. As a result of our efforts we can anticipate risks, make a list of them, assign probabilities and talk about them among the investment teams. We can collaborate one-on-one with our partners to discuss risk. Reducing the number of positions aligns with the first of our 10 pillars, Less is More, and informs our Risk 3.0 philosophy.

Risk management drives action.

Finally, for the "management" part of risk management, we have to make decisions. These take time and deliberation, and the resulting actions require agility and focus. A prerequisite is knowing and understanding the positions we own, and maintaining a limited number of them.

As an asset owner we are navigating a path, not staying fixed in a point in time. Risk is not a single data point, but rather a narrative where events might well dictate course corrections along the way. Consider these risk-related decisions that UC Investments faced over the first six months of the Covid crisis:

The bull market. We entered 2020 with the longest market expansion in history. With the expansion has come increasing vulnerability from rising leverage, concentration, and illiquidity. For example, ETFs on illiquid assets such as high yield bonds created a veneer of liquidity in markets that inherently are illiquid, with results that became apparent when these ETFs and their underlying markets struggled in March, and low volatility masked underlying build-up of market pressure that was briefly manifest with the volatility spike in early 2018.

This vulnerability underpinned our decision to increase cash holdings, with at least 5% and as much as 10% of our portfolios in cash from time to time. Cash held in our short-term investment pool earned us between 1% and 2%. Over the past several years, we had been advised to buy risk insurance to hedge our portfolios. In hindsight, these insurance policies would have proved more expensive to our performance than cash. We stayed away from these complexities because we prefer to keep it simple.

Geopolitical tensions. Although the China trade war was the most visible, there were broad tensions in the geopolitical sphere. We kept close tabs on our positions directly in China and other positions and risk factors that could be collateral damage. In the past four years, we have been closely monitoring our non-U.S. positions in general, especially in light of risks such as the rise of populism and authoritarian regimes. That has kept us overweight to the U.S.

Private credit. Investors have sought fresh corners of the private asset space, the dominant one being private credit. We made a decision to create a new private

credit asset class for risk management purposes, pulling this exposure into a single sleeve and placing limits on it. This bore fruit during March and April, when private credit experienced disproportionate losses.

Covid-19. A fundamental reality for Risk 3.0, and, indeed, any approach to risk, is that nobody can anticipate all possible events. Certainly the pandemic is a case in point. But we can assess our vulnerability to a surprise, and make adjustments to avoid facing a crisis with a challenged portfolio. Before Covid roiled the markets we saw market vulnerability marked by illiquidity and the concentration of positions. The key decision we made was to increase liquidity in our portfolios so that regardless of how this vulnerability resolves, we would not be in a position of forced selling.

Climate change. Seemingly lost with the current focus on the pandemic is the existential threat from climate change. Its most profound effects will likely come to the fore over the next decades, but the implications for market risk are more immediate. As investors increasingly realize the inevitability of the longer term effects, they will reprice assets today. We have added climate change analysis to our risk systems, and, consistent with our ESG objectives, have moved away from exposures in the path of climate change risk, most notably those related to fossil fuels.

Risk 3.0 Culture: Step by Step

The end objective of our work over the past five years has been to build a risk culture that embodies the key pillar of UC Investments, Risk Rules. We have found that risk culture is not abstract, nor is there a secret recipe for creating it. We have a blueprint in place, although not one etched in stone. There have been some false starts and adjustments along the way. And there remain many approaches to the same end goal. Every firm is different, and the best approach will vary as it is tailored to a firm's overall culture and investment goals.

At UC, we started by recognizing the inherent weakness of Risk 1.0 and Risk 2.0 and implementing new methods to overcome their limitations through the two steps we have described above: having a foundational understanding of the dimensions of market risk, and pulling together the structure, data, and tools to address those risks. What broadened it into a culture was a shared risk focus and language. The core of any culture is common language and expression, and so is the case for a risk culture. These cultures can be built.

Pick a risk language. Establish a common risk language that is used throughout the organization. This language describes the risks the portfolio faces given the realities of the current market environment. The description must use a risk system that pulls in positions and market information and delivers risk metrics for the portfolio. If the system cannot identify and express all of the risks, then it is insufficient. The language must be rich enough to express the complex dynamics of the market in real time, as well as to construct narratives for outside-the-box risks that no risk system can divine.

At UC Investments, our risk language includes risk factors, which show ways risk can thread through multiple assets in non-obvious ways. We spread our investments across a number of asset classes – public equity, private equity, real estate, real assets, fixed income, and private credit – but when we look at our risk from a factor perspective, we find that more than 80% of our risk is attributable to one factor, economic growth, because it appears prominently in most of our asset classes.

Communicate in that language. Make sure all investment professionals are fluent in the same risk language, that they understand the approach to risk, are aware of the state of the portfolio risk, and are active in discussions of risk in those terms, both internally and with stakeholders and clients. The hallmark of a strong risk culture is thoughtful discussion across the investment areas, particularly when the markets seem to be going off the rails.

Not everyone has the same asset focus and level of detail. The board will be briefed at a higher level than the focus of the CIO, who in turn will take a higher level view than a product head, whereas the stakeholder/client will have more detail on the specifics of

particular risks. This way, when things move from day-to-day to periods of major events and dislocations, everyone can effectively communicate about the issues at hand.

Turn communication into action. Finally, take action. If things stop with risk reports generated and recited in weekly investment meetings, it is a risk ritual, not a risk culture. We found that many decisions suffered from "analysis paralysis," entering an infinite loop of discussions. So we have buttressed communication and consensus building with points of accountability, which of course ultimately come to the CIO.

Risk 3.0 starts with a new paradigm, an agent-based model that reflects the dynamic, interactive nature of the markets. It combines with human experience and judgment, a departure from how static, historically based risk models are employed. Models need to relate to the way risk unfolds, not as a number, but as an ongoing narrative. And every narrative is different.