

## *Special Report: Understanding and Predicting Uncertainty Shocks*

It seems that wherever you look today, increased uncertainty is in the news. Investors are uncertain, and hence both anxiety and volatility are up. Business leaders are uncertain, so investment and employment are down. Households are uncertain, so consumption spending is down, and saving is up. And with the economic recovery stalling, policymakers and politicians are uncertain, leading to both action paralysis and increasingly rigid and stridently partisan rhetoric.

“High uncertainty” is also one of the three regimes we use in our market valuation analyses each month (the others being “high inflation” and “normal times”), in which short term domestic and foreign government bonds, volatility and gold are expected to deliver significantly better returns than other asset classes.

Clearly, sharp increases in uncertainty are a phenomenon we need to better understand, and, ideally, learn to predict in advance. And that is what we will attempt to do in this two part series. This month we will review the concept of uncertainty and how it affects our behavior. In our July 2010 issue, we will delve more deeply into what causes changes in the degree of uncertainty we perceive, and the extent to which these underlying causal factors may be predictable.

Much of our thinking about uncertainty has been influenced by the writing of Frank Knight, who was an economist of the old political-economy school, before the profession became dominated by deductive proofs and applied mathematics. In 1921, Knight published Risk, Uncertainty, and Profit. Chapter Three of that book, titled, “Imperfect Competition Through Risk and Uncertainty” is worth quoting at some length. Knight begins with an observation of the way the world works in practice, if not in theory: “The mental operations by which ordinary practical decisions are made are very obscure, and it is a matter for surprise that neither logicians nor psychologists have shown much interest in them. Perhaps (the writer is inclined to this view) it is

because there is really very little to say about the subject. Prophecy seems to be a good deal like memory itself, on which it is based. When we wish to think of some man's name, or recall a quotation which has slipped our memory, we go to work to do it, and the desired idea comes to mind, often when we are thinking about something else—or else it does not come, but in either case there is very little that we can tell about the operation, very little "technique." So when we try to decide what to expect in a certain situation, and how to behave ourselves accordingly, we are likely to do a lot of irrelevant mental rambling, and the first thing we know we find that we have made up our minds, that our course of action is settled. There seems to be very little meaning in what has gone on in our minds, and certainly little kinship with the formal processes of logic which the scientist uses in an investigation. We contrast the two processes by recognizing that the former is not reasoned knowledge, but "judgment," "common sense," or "intuition." There is doubtless some analysis of a crude type involved, but in the main it seems that we "infer" largely from our experience of the past as a whole, somewhat in the same way that we deal with intrinsically simple problems like estimating distances, weights, or other physical magnitudes, when measuring instruments are not at hand."

Knight then explores the different bases for forming these judgments. He initially begins with an exploration of probability estimates. "There are two fundamentally different ways of arriving at the probability judgment of the form that a given numerical proportion of *X*'s are also *Y*'s. The first method is by *a priori* calculation, and is applicable to and used in games of chance. This is also the type of case usually assumed in logical and mathematical treatments of probability. It must be strongly contrasted with the very different type of problem in which [*a priori*] calculation is impossible and the result is reached by the empirical method of applying statistics to actual instances [i.e., statistical induction] ... The import of this distinction for present purposes is that the first, mathematical or *a priori*, type of probability is practically never met with in business, while the second is extremely common."

Knight then goes on to identify a third basis for forming judgments, beyond deduction from theory (*a priori* reasoning) and inductive reasoning based on the use of

statistics: "the probability in which the student of business risk is interested *is* an estimate, though in a sense different from any of the propositions so far considered. To discuss the question from this new point of view we must go back for a moment to the general principles of the logic of conduct. We have emphasized above that the exact science of inference has little place in forming the opinions upon which decisions of conduct are based, and that this is true whether the implicit logic of the case is prediction on the ground of exhaustive analysis or a probability judgment, *a priori* or statistical. We act upon estimates rather than inferences, upon "judgment" or "intuition," not reasoning, for the most part. Now an estimate or intuitive judgment is somewhat like a probability judgment, but very different from either of the types of probability judgment already described. The relations between the two sorts are in fact amazingly complex and as fraught with logical paradox as the probability judgment itself. If the term "probability" is to be applied to an estimate—and the usage is so well established that there is no hope of getting away from it—a third species under that genus must be recognized. Such a third type of probability fits very nicely in a scheme of classification with the two already discussed. We have insisted that there is a fundamental difference between "*a priori*" probability, on the one hand, and "statistical," on the other. In the former the "chances" can be computed on general principles, while in the latter they can only be determined empirically... Taking, then, the classification point of view, we shall find the following simple scheme for separating three different types of probability situation:

1. *A priori* probability. Absolutely homogeneous classification of instances completely identical except for really indeterminate factors. This judgment of probability is on the same logical plane as the propositions of mathematics (which also may be viewed, and are viewed by the writer, as "ultimately" inductions from experience).
2. Statistical probability. Empirical evaluation of the frequency of association between predicates, not analyzable into varying combinations of equally probable alternatives. It must be emphasized that any high degree of confidence that the proportions found in the past will hold in the future is still

based on an a priori judgment of indeterminateness. Two complications are to be kept separate: first, the impossibility of eliminating all factors not really indeterminate; and, second, the impossibility of enumerating the equally probable alternatives involved and determining their mode of combination so as to evaluate the probability by a priori calculation. The main distinguishing characteristic of this type is that it rests on an empirical classification of instances.

3. Estimates. The distinction here is that there is no valid basis of any kind for classifying instances. This form of probability is involved in the greatest logical difficulties of all, and no very satisfactory discussion of it can be given, but its distinction from the other types must be emphasized and some of its complicated relations indicated...It is this third type of probability, or uncertainty, which has been neglected in economic theory.”

Knight then emphasizes that, “the theoretical difference between the probability connected with an estimate and that involved in such phenomena as are dealt with by insurance is, however, of the greatest importance, and is clearly discernible in nearly any instance of the exercise of judgment. Take as an illustration any typical business decision. A manufacturer is considering the advisability of making a large commitment in increasing the capacity of his works. He "figures" more or less on the proposition, taking account as well as possible of the various factors more or less susceptible of measurement, but the final result is an "estimate" of the probable outcome of any proposed course of action. What is the "probability" of error (strictly, of any assigned degree of error) in the judgment? It is manifestly meaningless to speak of either calculating such a probability *a priori* or of determining it empirically by studying a large number of instances. The essential and outstanding fact is that the "instance" in question is so entirely unique that there are no others or not a sufficient number to make it possible to tabulate enough like it to form a basis for any inference of value about any real probability in the case we are interested in. The same obviously applies to the most of conduct and not to business decisions alone. Yet it is true, and the fact can hardly be overemphasized, that a judgment of probability is actually made in such

cases. The business man himself not merely forms the best estimate he can of the outcome of his actions, but he is likely also to estimate the probability that his estimate is correct. The "degree" of certainty or of confidence felt in the conclusion after it is reached cannot be ignored, for it is of the greatest practical significance. The action which follows upon an opinion depends as much upon the amount of confidence in that opinion as it does upon the favorableness of the opinion itself. The ultimate logic, or psychology, of these deliberations is obscure, a part of the scientifically unfathomable mystery of life and mind. We must simply fall back upon a "capacity" in the intelligent animal to form more or less correct judgments about things, an intuitive sense of values. We are so built that what seems to us reasonable is likely to be confirmed by experience, or we could not live in the world at all... The opinions upon which we act in everyday affairs and those which govern the decisions of responsible business managers for the most part have little similarity with conclusions reached by exhaustive analysis and accurate measurement... Business decisions deal with situations which are far too unique, generally speaking, for any sort of statistical tabulation to have any value for guidance. The conception of an objectively measurable probability or chance is simply inapplicable...The mental processes are entirely different. In [the case of estimates] they are mostly subconscious."

Last but not least, Knight concluded that it was the existence of uncertainty that weakened the operation of competitive forces, and gave rise to the opportunity for earning profits above an investor's cost of capital.

Fifteen years after Frank Knight published Risk, Uncertainty, and Profit, John Maynard Keynes published his magnum opus, The General Theory of Employment, Interest and Money. Chapter 12 of Keynes' book ("The State of Long Term Expectation") further builds on Knight's original distinction between risk (a situation in which the likelihood of future outcomes could be derived from probability theory or statistical inference) and uncertainty (a situation in which a forecast of future outcomes, their likelihoods, and economic impact was based on subjective estimates). Again, it is worth quoting at some length, as Keynes' insights are critical and timeless.

“The considerations upon which expectations of prospective yields [long-term profits and cash flows, in modern terminology] are based are partly existing facts which we can assume to be known more or less for certain, and partly future events which can only be forecasted with more or less confidence...We can sum up the state of psychological expectation which covers the latter as being the state of long term expectation...The state of long-term expectation, upon which our decisions are based, does not solely depend on the most probable forecast we can make. It also depends on the confidence with which we make this forecast – on how highly we rate the likelihood of our best forecast turning out quite wrong. If we expect large changes but are very uncertain as to what precise form these changes will take, then our confidence will be weak. ‘The state of confidence’, as they term it, is a matter to which practical men always pay the closest and most anxious attention. But economists have not analyzed it carefully and have been content, as a rule, to discuss it in general terms. In particular, it has not been made clear that its relevance to economic problems comes through its important influence on [investment]...There is, however, not much to be said about the state of confidence a priori. Our conclusions must mainly depend upon the actual observation of markets and business psychology...”

“The outstanding fact is the extreme precariousness of the basis of knowledge on which our estimates of prospective yield have to be made. Our knowledge of the factors which will govern the yield on an investment some years hence is usually very slight and often negligible...In fact, those who seriously attempt to make any such estimate are so much in the minority that their behavior does not govern the market. In former times, when enterprises were mainly owned by those who undertook them or by their friends and associates, investment depended on a sufficient supply of individuals of sanguine temperament and constructive impulses who embarked on business as a way of life, not really relying on a precise calculation of prospective profit. The affair was partly a lottery, though with the ultimate result largely governed by whether the abilities and character of the managers were above or below the average...Businessmen play a mixed game of skill and chance... Decisions to invest in private business of the old-fashioned type were, however, decisions largely

irrevocable, not only for the community as a whole, but also for the individual. With the separation between ownership and management which prevails to-day and with the development of organised investment markets, a new factor of great importance has entered in, which sometimes facilitates investment but sometimes adds greatly to the instability of the system. In the absence of security markets, there is no object in frequently attempting to revalue an investment to which we are committed. But the Stock Exchange revalues many investments every day and the revaluations give a frequent opportunity to the individual (though not to the community as a whole) to revise his commitments. It is as though a farmer, having tapped his barometer after breakfast, could decide to remove his capital from the farming business between 10 and 11 in the morning and reconsider whether he should return to it later in the week. But the daily revaluations of the Stock Exchange, though they are primarily made to facilitate transfers of old investments between one individual and another, inevitably exert a decisive influence on the rate of current investment. For there is no sense in building up a new enterprise at a cost greater than that at which a similar existing enterprise can be purchased; whilst there is an inducement to spend on a new project what may seem an extravagant sum, if it can be floated off on the Stock Exchange at an immediate profit. Thus certain classes of investment are governed by the average expectation of those who deal on the Stock Exchange as revealed in the price of shares, rather than by the genuine expectations of the professional entrepreneur. How then are these highly significant daily, even hourly, revaluations of existing investments carried out in practice?"

"In practice we have tacitly agreed, as a rule, to fall back on what is, in truth, a *convention*. The essence of this convention — though it does not, of course, work out quite so simply — lies in assuming that the existing state of affairs will continue indefinitely, except in so far as we have specific reasons to expect a change. This does not mean that we really believe that the existing state of affairs will continue indefinitely. We know from extensive experience that this is most unlikely. The actual results of an investment over a long term of years very seldom agree with the initial expectation...We are assuming, in effect, that the existing market valuation, however

arrived at, is uniquely *correct* in relation to our existing knowledge of the facts which will influence the yield of the investment, and that it will only change in proportion to changes in this knowledge; though, philosophically speaking it cannot be uniquely correct, since our existing knowledge does not provide a sufficient basis for a calculated mathematical expectation. In point of fact, all sorts of considerations enter into the market valuation which are in no way relevant to the prospective yield. Nevertheless the above conventional method of calculation will be compatible with a considerable measure of continuity and stability in our affairs, *so long as we can rely on the maintenance of the convention*. For if there exist organised investment markets and if we can rely on the maintenance of the convention, an investor can legitimately encourage himself with the idea that the only risk he runs is that of a genuine change in the news *over the near future*, as to the likelihood of which he can attempt to form his own judgment, and which is unlikely to be very large. For, assuming that the convention holds good, it is only these changes that can affect the value of his investment, and he need not lose his sleep merely because he has not any notion what his investment will be worth ten years hence. Thus investment becomes reasonably “safe” for the individual investor over short periods, and hence over a succession of short periods however many, if he can fairly rely on there being no breakdown in the convention and on his therefore having an opportunity to revise his judgment and change his investment, before there has been time for much to happen. Investments which are “fixed” for the community are thus made “liquid” for the individual.”

“It has been, I am sure, on the basis of some such procedure as this that our leading investment markets have been developed. But it is not surprising that a convention, in an absolute view of things so arbitrary, should have its weak points. It is its precariousness which creates no small part of our contemporary problem of securing sufficient investment. Some of the factors which accentuate this precariousness may be briefly mentioned:

(1) As a result of the gradual increase in the proportion of the equity in the community’s aggregate capital investment which is owned by persons who do not



manage and have no special knowledge of the circumstances, either actual or prospective, of the business in question, the element of real knowledge in the valuation of investments by those who own them or contemplate purchasing them has seriously declined.

(2) Day-to-day fluctuations in the profits of existing investments, which are obviously of an ephemeral and non-significant character, tend to have an altogether excessive, and even an absurd, influence on the market. It is said, for example, that the shares of American companies which manufacture ice tend to sell at a higher price in summer when their profits are seasonally high than in winter when no one wants ice. The recurrence of a bank-holiday may raise the market valuation of the British railway system by several million pounds.

(3) A conventional valuation which is established as the outcome of the mass psychology of a large number of ignorant individuals is liable to change violently as the result of a sudden fluctuation of opinion due to factors which do not really make much difference to the prospective yield; since there will be no strong roots of conviction to hold it steady. In abnormal times in particular, when the hypothesis of an indefinite continuance of the existing state of affairs is less plausible than usual even though there are no express grounds to anticipate a definite change, the market will be subject to waves of optimistic and pessimistic sentiment, which are unreasoning and yet in a sense legitimate where no solid basis exists for a reasonable calculation.

(4) But there is one feature in particular which deserves our attention. It might have been supposed that competition between expert professionals, possessing judgment and knowledge beyond that of the average private investor, would correct the vagaries of the ignorant individual left to himself. It happens, however, that the energies and skill of the professional investor and speculator are mainly occupied otherwise. For most of these persons are, in fact, largely concerned, not with making superior long-term forecasts of the probable yield of an investment over its whole life, but with foreseeing changes in the conventional basis of valuation a short time ahead of the general public. They are concerned, not with what an investment is really worth to a man who buys it "for keeps", but with what the market will value it at, under the

influence of mass psychology, three months or a year hence. Moreover, this behaviour is not the outcome of a wrong-headed propensity. It is an inevitable result of an investment market organised along the lines described. For it is not sensible to pay 25 for an investment of which you believe the prospective yield to justify a value of 30, if you also believe that the market will value it at 20 three months hence...

(5) So far we have had chiefly in mind the state of confidence of the speculator or speculative investor himself and may have seemed to be tacitly assuming that, if he himself is satisfied with the prospects, he has unlimited command over money at the market rate of interest. This is, of course, not the case. Thus we must also take account of the other facet of the state of confidence, namely, the confidence of the lending institutions towards those who seek to borrow from them, sometimes described as the state of credit. A collapse in the price of equities, which has had disastrous reactions on the marginal efficiency of capital, may have been due to the weakening either of speculative confidence or of the state of credit. But whereas the weakening of either is enough to cause a collapse, recovery requires the revival of *both*. For whilst the weakening of credit is sufficient to bring about a collapse, its strengthening, though a necessary condition of recovery, is not a sufficient condition..."

"Thus the professional investor is forced to concern himself with the anticipation of impending changes, in the news or in the atmosphere, of the kind by which experience shows that the mass psychology of the market is most influenced. This is the inevitable result of investment markets organised with a view to so-called "liquidity". Of the maxims of orthodox finance none, surely, is more anti-social than the fetish of liquidity, the doctrine that it is a positive virtue on the part of investment institutions to concentrate their resources upon the holding of "liquid" securities. It forgets that there is no such thing as liquidity of investment for the community as a whole. The social object of skilled investment should be to defeat the dark forces of time and ignorance which envelop our future. The actual, private object of the most skilled investment to-day is "to beat the gun", as the Americans so well express it, to outwit the crowd, and to pass the bad, or depreciating, half-crown to the other fellow... If the reader interjects that there must surely be large profits to be gained from the

other players in the long run by a skilled individual who, unperturbed by the prevailing pastime, continues to purchase investments on the best genuine long-term expectations he can frame, he must be answered, first of all, that there are, indeed, such serious-minded individuals and that it makes a vast difference to an investment market whether or not they predominate in their influence over the game-players. But we must also add that there are several factors which jeopardise the predominance of such individuals in modern investment markets. Investment based on genuine long-term expectation is so difficult to-day as to be scarcely practicable. He who attempts it must surely lead much more laborious days and run greater risks than he who tries to guess better than the crowd how the crowd will behave; and, given equal intelligence, he may make more disastrous mistakes. There is no clear evidence from experience that the investment policy which is socially advantageous coincides with that which is most profitable. It needs more intelligence to defeat the forces of time and our ignorance of the future than to beat the gun. Moreover, life is not long enough; — human nature desires quick results, there is a peculiar zest in making money quickly, and remoter gains are discounted by the average man at a very high rate... It is the long-term investor, he who most promotes the public interest, who will in practice come in for most criticism, wherever investment funds are managed by committees or boards or banks. For it is in the essence of his behaviour that he should be eccentric, unconventional and rash in the eyes of average opinion. If he is successful, that will only confirm the general belief in his rashness; and if in the short run he is unsuccessful, which is very likely, he will not receive much mercy. Worldly wisdom teaches that it is better for reputation to fail conventionally than to succeed unconventionally...”

“Even apart from the instability due to speculation, there is the instability due to the characteristic of human nature that a large proportion of our positive activities depend on spontaneous optimism rather than on a mathematical expectation, whether moral or hedonistic or economic. Most, probably, of our decisions to do something positive, the full consequences of which will be drawn out over many days to come, can only be taken as a result of animal spirits — of a spontaneous urge to action

rather than inaction, and not as the outcome of a weighted average of quantitative benefits multiplied by quantitative probabilities... Thus if the animal spirits are dimmed and the spontaneous optimism falters, leaving us to depend on nothing but a mathematical expectation, enterprise will fade and die; — though fears of loss may have a basis no more reasonable than hopes of profit had before... This means, unfortunately, not only that slumps and depressions are exaggerated in degree, but that economic prosperity is excessively dependent on a political and social atmosphere which is congenial to the average business man. If the fear of a Labour Government or a New Deal depresses enterprise, this need not be the result either of a reasonable calculation or of a plot with political intent; — it is the mere consequence of upsetting the delicate balance of spontaneous optimism. In estimating the prospects of investment, we must have regard, therefore, to the nerves and hysteria and even the digestions and reactions to the weather of those upon whose spontaneous activity it largely depends. We should not conclude from this that everything depends on waves of irrational psychology. On the contrary, the state of long-term expectation is often steady, and, even when it is not, the other factors exert their compensating effects. We are merely reminding ourselves that human decisions affecting the future, whether personal or political or economic, cannot depend on strict mathematical expectation, since the basis for making such calculations does not exist; and that it is our innate urge to activity which makes the wheels go round, our rational selves choosing between the alternatives as best we are able, calculating where we can, but often falling back for our motive on whim or sentiment or chance.”

Let us now jump forward to a much more recent reflection on uncertainty, Andrew Lo and Mark Mueller’ “Warning: Physics Envy May Be Hazardous to Your Wealth!” The authors note that the goal of their paper is “to provide a framework for investors, portfolio managers, regulators and policymakers in which the efficacy and limitations of economics and finance can be more readily understood...We hope to show through a series of examples drawn from both physics and finance that the failure of quantitative models in economics is almost always the result of a mismatch between the type of uncertainty in effect and the methods used to manage it.

Moreover, the process of scientific discovery may be viewed as the means by which we transition from one level of uncertainty to the next.” Lo and Mueller stress that “the distinctions between various types of uncertainty are central to the differences between economics and physics.” Noting that “economists have been aware of some of these distinctions for decades, beginning with Frank Knight’s dissertation in 1921”, they “propose an even more refined taxonomy of uncertainty, that is capable of explaining the differences across the entire spectrum of intellectual pursuits from physics to biology to economics to philosophy and religion.” Here is how Lo and Mueller describe the spectrum of uncertainty:

“Level 1: Complete Certainty. This is the realm of classical physics, an idealized deterministic world governed by Newton’s laws of motion. All past and future states of the system are determined exactly if initial conditions are fixed and known—nothing is uncertain. Of course, even within physics, this perfectly predictable clockwork universe of Newton, Lagrange, LaPlace, and Hamilton was recognized to have limited validity as quantum mechanics emerged in the early twentieth century. Even within classical physics, the realization that small perturbations in initial conditions can lead to large changes in the subsequent evolution of a dynamical system underscores how idealized and limited this level of description can be in the elusive search for truth. However, it must be acknowledged that much of the observable physical universe does, in fact, lie in this realm of certainty...In this respect, physics has enjoyed a significant head start when compared to all the other sciences.”

“Level 2: Risk without Uncertainty. This level of randomness is Knight’s (1921) definition of risk: randomness governed by a known probability distribution for a completely known set of outcomes. At this level, probability theory is a useful analytical framework for risk analysis... No statistical inference is needed, because we know the relevant probability distributions exactly, and while we do not know the outcome of any given wager, we know all the rules and the odds, and no other information relevant to the outcome is hidden. This is life in a hypothetical honest casino, where the rules are transparent and always followed. This situation bears little resemblance to financial markets.”

“Level 3: Fully Reducible Uncertainty. This is risk with a degree of uncertainty, an uncertainty due to unknown probabilities for a fully enumerated set of outcomes that we presume are still completely known. At this level, classical (frequentist) statistical inference must be added to probability theory as an appropriate tool for analysis. By “fully reducible uncertainty”, we are referring to situations in which randomness can be rendered arbitrarily close to Level-2 uncertainty with sufficiently large amounts of data using the tools of statistical analysis. Fully reducible uncertainty is very much like an honest casino, but one in which the odds are not posted and must therefore be inferred from experience. In broader terms, fully reducible uncertainty describes a world in which a single model generates all outcomes, and this model is parameterized by a finite number of unknown parameters that do not change over time and which can be estimated with an arbitrary degree of precision given enough data. The resemblance to the “scientific method”—at least as it is taught in science classes today—is apparent at this level of uncertainty. One poses a question, develops a hypothesis, formulates a quantitative representation of the hypothesis (i.e., a model), gathers data, analyzes that data to estimate model parameters and errors, and draws a conclusion. Human interactions are often a good deal messier and more nonlinear, and we must entertain a different level of uncertainty before we encompass the domain of economics and finance.”

“Level 4: Partially Reducible Uncertainty. Continuing our descent into the depths of the unknown, we reach a level of uncertainty that now begins to separate the physical and social sciences, both in philosophy and model building objectives. By Level-4 or “partially reducible” uncertainty, we are referring to situations in which there is a limit to what we can learn about the underlying phenomena generating the data [either deductively using probability or inductively using statistics]. Examples include data-generating processes that exhibit: (1) stochastic or time-varying parameters that vary too frequently to be estimated accurately; (2) nonlinearities too complex to be captured by existing models, techniques, and datasets; (3) nonstationarities that render useless the Law of Large Numbers, Central Limit Theorem, and other methods of statistical inference and approximation; and (4) the dependence on relevant but

unknown and unknowable conditioning information. Although the laws of probability still operate at this level, there is a non-trivial degree of uncertainty regarding the underlying structures generating the data that cannot be reduced to Level-2 uncertainty, even with an infinite amount of data. Under partially reducible uncertainty, we are in a casino that may or may not be honest, and the rules tend to change from time to time without notice. In this situation, classical statistics may not be as useful as a Bayesian perspective, in which probabilities are no longer tied to relative frequencies of repeated trials, but now represent degrees of belief. Using Bayesian methods, we have a framework and lexicon with which partial knowledge, prior information, and learning can be represented more formally. Level-4 uncertainty involves “model uncertainty”, not only in the sense that multiple models may be consistent with observation, but also in the deeper sense that more than one model may very well be generating the data...At this level of uncertainty, modeling philosophies and objectives in economics and finance begin to deviate significantly from those of the physical sciences. Physicists believe in the existence of fundamental laws, either implicitly or explicitly, and this belief is often accompanied by a reductionist philosophy that seeks the fewest and simplest building blocks from which a single theory can be built. Even in physics, this is an over-simplification, as one era’s “fundamental laws” eventually reach the boundaries of their domains of validity, only to be supplanted and encompassed by the next era’s “fundamental laws”. The classic example is, of course, Newtonian mechanics becoming a special case of special relativity and quantum mechanics. It is difficult to argue that economists should have the same faith in a fundamental and reductionist program for a description of financial markets (although such faith does persist in some, a manifestation of physics envy). Markets are tools developed by humans for accomplishing certain tasks—not immutable laws of Nature—and are therefore subject to all the vicissitudes and frailties of human behavior. While behavioral regularities do exist, and can be captured to some degree by quantitative methods, they do not exhibit the same level of certainty and predictability as physical laws. Accordingly, model-building in the social sciences should be much less informed by mathematical aesthetics, and much more by

pragmatism in the face of partially reducible uncertainty. We must resign ourselves to models with stochastic parameters or multiple regimes that may not embody universal truth, but are merely useful, i.e., they summarize some coarse-grained features of highly complex datasets.”

“Level 5: Irreducible Uncertainty. Irreducible uncertainty is the polite term for a state of total ignorance; ignorance that cannot be remedied by collecting more data, using more sophisticated methods of statistical inference or more powerful computers, or thinking harder and smarter. Such uncertainty is beyond the reach of probabilistic reasoning, statistical inference, and any meaningful quantification. This type of uncertainty is the domain of philosophers and religious leaders, who focus on not only the unknown, but the unknowable. Stated in such stark terms, irreducible uncertainty seems more likely to be the exception rather than the rule. After all, what kinds of phenomena are completely impervious to quantitative analysis, other than the deepest theological conundrums? The usefulness of this concept is precisely in its extremity. By defining a category of uncertainty that cannot be reduced to any quantifiable risk—essentially an admission of intellectual defeat—we force ourselves to stretch our imaginations to their absolute limits before relegating any phenomenon to this level.”

Having looked at three different analyses of uncertainty (spanning 80 years), let us now turn to a brief review of its practical impact. In a few words, it is infrequent but very powerful. Most of the time, we operate with a relatively low level of perceived uncertainty. But when our sense of uncertainty changes, many things happen. As we have noted in the past, at the level of the individual actor, an increase in uncertainty is one of the three main triggers of the unconscious “fear response” in the part of our brain known as the amygdala. The other two triggers are various types of loss (e.g., actual loss of resources – say a big drop in portfolio value – or relative loss – say, a portfolio’s returns falling behind an important reference point, like an index, required rate of return, or the results of a group of friends or competitors), and social isolation. In practice, these three triggers are interrelated, for example, because it has also been shown that our need for the support of a group (and hence fear of social isolation) increases with our experience of loss or heightened uncertainty. All of these



unconscious and automatic emotional responses clearly helped us to survive on the East African plain eons ago, and have been “hard-wired” into our human nature.

At the other end of the spectrum, changes in perceived uncertainty have also been shown to have a powerful impact on macroeconomic activity and financial market returns. For example, in “The Impact of Macroeconomic Uncertainty on Bank Lending Behavior”, Baum, Caglayan, and Ozkan find that “as macroeconomic uncertainty increases, banks behave more conservatively.” In “The Impact of Uncertainty Shocks”, Nicholas Bloom finds that macro-uncertainty shocks “produce a rapid drop in aggregate output and employment...which occur because higher uncertainty causes firms to temporarily pause in their investment and hiring.” Pablo Guerron-Quintana of the Federal Reserve Bank of Philadelphia finds that uncertainty shocks affect exchange rates (“Do Uncertainty and Technology Drive Exchange Rates?”). And in “Uncertainty and Economic Activity: Evidence from Business Survey Data”, Bachmann, Elstner and Sims find that uncertainty shocks (or their opposite, declines in business confidence) have long-lived (5 to 10 year) effects, “leading robustly to very prolonged declines in economic activity.” The impact of public policy uncertainty on the length and depth of the Great Depression was also the subject of Amity Shlaes excellent book, [The Forgotten Man: A New History of the Great Depression](#). In recent months, this theme has once again emerged in the popular press (see, for example, “Obama’s CEO Problem” by Fareed Zakaria in the 5July10 *Washington Post*, and General Electric CEO Jeff Immelt’s recent criticisms of the Obama administration’s policies towards business). Last but not least, sharp rises in uncertainty also have a strong impact on the prices, valuations and returns earned by investors in different asset classes. At this point, we have hopefully provided you with a better understanding of the nature and importance of uncertainty shocks to both real economic activity and financial market returns and volatility. The questions we will examine in Part 2 are, (1) What causes sharp changes in uncertainty? And (2), can these changes be predicted?

## **Understanding and Predicting Uncertainty Shocks, Part 2**

Changes in perceived uncertainty are rooted in both individual and collective/network factors, and can be both endogenous (internal) and exogenous (external) to the system in question. Let's look at each of these in turn. At the individual level, for many years we have organized our thinking about investor behavior using the following model:

1. An individual attends external/environmental stimuli on two levels. The first is conscious, and driven by his or her mental model of a situation, which includes accurate perception of its key element, understanding of their meaning and significance, and forecasts for how events are likely to evolve in the near-term in response to possible actions. These are often referred to as the three levels of situational awareness. The second aspect of an individual's attention to his or her environment is subconscious, and driven by factors that helped ensure our remote ancestors' survival in the harsh conditions of the East African plain. This directs attention to social cues, particularly indications of fear in others, signs of actual danger, large or rapid changes in the surrounding environment that could represent a potential threat, stimuli that are novel and/or vivid, and possible sources of immediate reward and satisfaction of basic needs.
2. Stimuli are consciously evaluated using our cognitive capabilities.
3. This cognitive evaluation either dampens or reinforces our initial emotional evaluation of the stimuli.
4. On the basis of our thoughts and feelings, we first search our repertoire of remembered actions to see if one or more can be used to achieve our goals in the current situation. These goals are both conscious/cognitive and often unconscious/emotional. The latter group includes avoiding loss of resources and/or relative social standing, reducing uncertainty, and avoiding social isolation. If an available course of action does not appear to have a sufficiently high probability of achieving our goals, we have to take more time to consciously develop an action plan, mentally simulate its likely results, and

decide whether its likelihood of success is high enough to proceed; if it does not, we repeat the process, if time is available. If it isn't, we execute the available course of action with the highest likelihood of success.

5. We take action.
6. Random factors (i.e., good and bad luck) affect the outcome of our action.
7. Our action combines with the actions of others in sometimes unpredictable ways to generate aggregate outcomes that we observe.
8. Depending on how those outcomes compare to our goals and expectations, we either repeat the process or shift out attention to higher priority stimuli.

Let us look at these in more detail, with an eye towards better understanding how they can be a source of a sharp increase in our perception of uncertainty. In terms of the allocation of scarce attention, we believe that the ability of humans to detect fear in others, even in the absence of verbal communication, is a critical source of a heightened sense of uncertainty. Moreover, this has become a much more powerful channel in an age of increased urbanization, low cost global communication (of not just text, but also real time audio and video), and hyper connectivity (e.g., count how many more ways you are connected to other people today than you were ten years ago). Another factor which has primed us for uncertainty spikes may also be the tendency, in an age of information overload, for senders of messages to make their communications more vivid and emotionally charged, in an attempt to attract the attention of their target audience (think, for example, of how life insurance or health care advertising often seeks to play on our fears). In other words, if you assume that as human beings we have a limited emotional capacity to cope with uncertainty, technological changes may have resulted in more of this capacity being used up on a daily basis than was the case in the past, and as a society we may therefore be operating closer to the "uncertainty spike" threshold. Rising sales of anxiety management drugs over the past twenty years seems to further support this view.

The normal functioning of our cognitive processes can also lead to sharp increases in perceived uncertainty. As many analysts have noted, we initially establish our mental models on the basis of relatively little information (e.g., deductively from

available concepts, or inductively from available experience). However, once established, our mental models control the way we attend to and weight subsequent information, and update our prior views. In particular, three common phenomena can easily lead to surprise, and a sudden increase in perceived uncertainty. First, we naturally tend to be over-optimistic – e.g., to overestimate the average (mean) return on an asset class over the next ten years. While some researchers pejoratively call this tendency a bias, other researchers have shown how over-optimism can confer evolutionary advantages (see, “On the Evolutionary Emergence of Optimism” by Heifetz and Spiegel). Second, we naturally tend to be over-confident – that is, to underestimate the range of possible future outcomes around the mean or most likely outcome. In “Overconfidence is a Social Signaling Bias”, Burks, Carpenter and their colleagues show how “overconfidence is induced by the desire to send positive signals to others about one’s skill”, and how “sending overconfident signals, irrespective of ability, could be socially beneficial to the sender.”

Similar conclusions are reached by Radzevick and Moore in their paper, “Competing to Be Certain (But Wrong): Social Pressure and Overprecision in Judgment.” They study the impact of financial advisor confidence, and note how competition with other advisors for clients’ business leads to advisors becoming more overconfident. Along those same lines, Price and Stone find that overconfident advisors are rated as more accurate, even if they aren’t (“Intuitive Evaluation of Likelihood Judgment Producers”). Finally, we tend to give more attention and weight to information which confirms our existing mental model, rather than information which disconfirms it. Some researchers believe that this is a logical outcome of our desire to conserve scarce cognitive processing capacity (see “From Perception to Action: An Economic Model of Brain Processes” by Brocas and Carrillo). Interestingly, in the context of investments, Ko and Huang find that when an investment we own has lost money, we are particularly likely to interpret new information in a positive manner. This confirmation bias was much stronger than when we receive new information about a stock which has recently experienced a gain. They conclude that investor beliefs are more persistent when they are losing money, which is consistent with other studies

which find that momentum effects are driving more by loser than by winner stocks (see “Persistence of Beliefs in an Investment Experiment”). In our view, this study highlights the complex interaction between our cognitive processing (e.g., the confirmation bias) and our emotional processing (our desire to avoid absolute or relative losses). Other researchers have attributed the confirmation bias to our psychological need to maintain coherence of our mental models, including our representations of concepts, beliefs, goals and actions. Again, one can also interpret this as an emotional desire to avoid loss – in this case, loss of the certainty and security provided by a coherent model (for more on this, see Paul Thagard’s book, Coherence in Thought and Action). In practice, these biases set the stage for surprise, as they enable the development of an increasingly larger gap between our mental model/situation awareness and reality. When accumulated evidence finally forces an investor to recognize that his or her mental model needs to be substantially revised, the normal result is a sharp increase in uncertainty and fear as situation awareness is lost.

We like to use the following matrix to describe the range of reactions we have encountered in both individuals and organizations over the years:

***Degree of Perceived Uncertainty***

<b><i>Goal Achievement?</i></b>	Moderate Uncertainty: I’m achieving my goals, but I no longer think I understand the situation	Minimum Uncertainty: I’m achieving my goals and I understand the situation I face
	Maximum Uncertainty: I’m falling short of my goals and I no longer understand the situation I face	Low Uncertainty: I’m falling short of my goals, but I understand the situation and know what I have to change

***Situation Awareness?***

Let us now move from endogenous individual to endogenous collective sources of sharp increases in uncertainty. Social networks are central to our identity as human

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beings, and our evolutionary progress over the ages (see, for example, “Humans: Why They Triumphed” by Matt Ridley in the 22May2010 *Wall Street Journal*). However, it is only recently that researchers have realized the importance of social networks to understanding economics and finance (see, for example, “Overview of Social Networks and Economic Applications” by Matthew Jackson, and the many works of Didier Sornette on this subject). In the economic context, perhaps the most studied networks are those termed “scale free”, which means that their distribution of the number of connections between a given node and other nodes follows a power law. Many human networks have this property, being characterized by a relatively small number of very highly connected individuals, and a much larger number of individuals with a far smaller number of connections to other people (i.e., to other network nodes). Other researchers have shown that when individual behavior is influenced to a degree between zero and 100% by inputs from others in a scale free network, it produces fluctuations in growth that have very similar power law distribution across a wide range of phenomena, from GDP growth rates to the size distribution of U.S. firms to money invested in mutual funds (see “The Cause of Universality in Growth Fluctuations” by Schwarzkopf, Axtell and Farmer). This means that the production of a very small number of large changes is inherent in the structure and operation of the scale free network and its influence on individual decisions.

In an investment context, agent-based modeling of networks of traders employing different strategies (e.g., fundamental value and trend-following), has shown the interaction between traders (comparing their performance to others, and modifying their existing strategy when it fails to produce satisfactory results) produces a preference for trend-following and other technical strategies, despite their tendency to sometimes generate substantial booms and busts (see “A Prisoner’s Dilemma Causes Technical Trading” by Joshi, Parker, and Bedau). This process also tends to produce the “crowded trades” and rising correlations that were observed in the run-up to the most recent financial crisis. It should also be noted that the use of leverage accentuates both the size of the bubbles and the ferocity of the crashes that can result from these dynamics (e.g., see “Leverage Causes Fat Tails and Clustered Volatility”

by Thurner, Farmer, and Geanakoplos). These factors are also the basis for two other papers that highlight how network connections lie at the root of contagion and systemic risk in the world financial system (see “Contagion in Financial Networks” by Gai and Kapadia and “Systemic Risk in a Unifying Framework for Cascading Processes on Networks” by Lorenz, Battiston, and Schweitzer).

In a different, but equally important context, Niall Ferguson has shown how complex network relationships can also help to explain the sudden collapse of political systems (see “Complexity and Collapse: Empires on the Edge of Chaos”). And in “Inductive Game Theory and the Dynamics of Animal Conflict”, DeDeo, Krakauer, and Flack concluded that networks were at the heart of conflict. They conclude that individuals “base their decision to fight on memory of social factors, not on short timescale resource competition. Furthermore, the social assessments on which these decisions are based are triadic (self in relation to two other individuals), not pairwise. This triadic decision making can cause long conflict cascades that generate a high cost.” They conclude that “individual agency has been over-emphasized in the social evolution of complex networks, and that pairwise theories are inadequate.”

In the corporate world, many analysts have noted the unintended side effects of the process re-engineering undertaken by so many companies in the 1990s. While seeking to improve efficiency (and profits) by making existing processes more efficient, they eliminated the excess (or “slack”) resources that enabled companies to absorb and recover from unexpected shocks. In this manner, the pursuit of highly efficient and stable operations, sometimes reinforced by the use of high leverage (which was often called a “more efficient capital structure”), created a false sense of corporate strength, as these same moves made organizations much less robust in the face of uncertainty. Moreover, as we are now learning, the creation of larger and more interconnected global supply chain networks in the name of efficiency has also exposed many companies to new sources of uncertainty and external shocks (e.g., loss of intellectual property, loss of core capabilities, and heightened exposure to political risk and disruptions caused by the failure of critical nodes, etc.).

Other researchers have found that the way connections are formed between network nodes affects the rate of diffusion and learning among different groups within a scale free network. For example, when people prefer to form connections with people who are similar to themselves, the rate of learning in a network is slowed (see “How Homophily Affects Diffusion and Learning in Networks” by Golub and Jackson). Again, differential learning rates across groups can cause large surprises for some. In addition to the way social networks can influence the diffusion of information, speed of learning, and cognitive decisions, they can also influence individuals’ emotions. For example, envy can be interpreted as fear that one’s relative social standard has been diminished due to another’s gain. Like all fears, envy is easily conveyed through social networks, and triggers a heightened fear of social isolation, or, viewed differently, a stronger impulse to stay with the group. Similarly, a sudden market crash will also trigger fear, both directly and via the heightened uncertainty it likely creates for many investors. And again, this fear is easily transmitted across a social network, which in turn raises affected individuals’ desire to stay with the group for security. As previously noted, these responses are all easily seen as mechanisms that enhanced our ancestors’ survival prospects on the East African plain. For investors, however, the self-reinforcing nature of collective emotions can easily lead to heightened feelings of uncertainty.

Thus far, we have shown how, at both the individual and collective level, sudden increases in uncertainty are endogenous (i.e., wired into) the operation of our processes and systems. It goes without saying that more traditional exogenous factors (e.g., a technological change or major hurricane) can also cause sudden spikes in uncertainty. However, in our view these spikes are more likely to be transitory than the uncertainty shocks that result from the operation of the system itself, which most people find much harder to understand. The “flash crash” on 6 May 2010 provides an excellent recent example of this phenomenon. A relatively normal trade, undertaken when a variety of trading algorithms (i.e., quantitative strategies) had apparently concluded the U.S. equity market was at a critical point, caused an unprecedented intra-day fall in the value of the Dow Jones Index. Yet commentators, government and



market officials have yet to provide a clear explanation of just how this “mini-crash” occurred. As such, the rise in uncertainty it caused is likely to still exist for many investors.

The next question to ask is the extent to which sharp increases in uncertainty can be predicted in advance. Since we are operating in the realm of Lo and Mueller’s Level-4 uncertainty, quantitative modeling alone is unlikely to provide a satisfactory forecast -- some degree of qualitative analysis is also needed to generate insight. We believe that the key to such an approach lies in an appreciation of two concepts. The first is the three levels of situation awareness: (1) perception of the key elements in a situation; (2) comprehension of their meaning; and (3) projection of how they are likely to evolve in the short-term. The second is John Maynard Keynes’ “beat the gun” analogy, where the object of a game is to most accurately predict the future behavior of other investors.

We believe that the likelihood of a person experiencing a strong surprise, and spike in perceived/felt uncertainty, is directly related to how he or she perceives his or her level of situation awareness. More specifically, we believe that uncertainty increases non-linearly as one perceives failures at successive levels of situation awareness (or, viewed another way, perceives successively more serious shortcomings in one’s mental model). At the third (highest) level of situation awareness, failure to accurately project how a situation will evolve usually doesn’t sharply increase uncertainty because people realize that a certain degree of forecast inaccuracy is inevitable and inescapable.

More upsetting is failure at the second level of situation awareness: to comprehend, and be able to explain, the current meaning of the key elements one perceives. For example, in light of the 6 May 2010 “flash crash”, do you think people have become more uncertain about what causes stock prices to change, sometimes by very large amounts in a single day? What is the relative importance of changes in fundamental value, changes in perceptions of future investors behavior, or the actions of computer trading programs that employ extremely complex and high volume strategies?

The most unsettling circumstance, which is almost guaranteed to spike the feeling of uncertainty, is when a person realizes that a failure of Level 1 situation awareness has occurred – that they haven't been paying attention to factors or issues that are critical to the achievement of an important goal (say, financial security, or earning this year's performance bonus). Put differently, when you realize you haven't even been paying attention to the right signals, never mind being able to explain their meaning or use them to predict the future, you know you are in trouble. If there is any doubt about that, think about people's reaction when they are shocked to learn that they are getting fired, or their spouse wants a divorce. Under these circumstances, how many times have you heard, "I didn't even see it coming? How could I have been so clueless and not seen the signs?" And how long does it take for a person who has gone through one (or both) of these experiences to once again trust his or her judgment about job or relationship security – to reestablish a mental model and level of situation awareness that they trust?

The Keynesian/"beat the gun" aspect of uncertainty spikes is that, when it comes to predicting shifts to the High Uncertainty Regime, what counts is an accurate forecast of when investors who have the greatest impact on prices will discover their situation awareness is seriously deficient. In today's market, those investors – the market's "center of gravity" if you will -- are not easy to identify. Is it the algorithmic traders, and their high frequency trading programs? Or do these players simply magnify the impact of human investors' increased uncertainty? Is it the hedge fund community? Or are they generally savvy enough to exploit these uncertainty spikes? Is it institutions like endowments and pensions? Or are their time horizons so long term that they are less affected by uncertainty spikes? Or does the center of market gravity lie with relatively affluent individuals who account for the bulk of mutual fund holdings, as well as a disproportionate share of private consumption spending?

Once "center of gravity" investors have been identified, the process of exploiting uncertainty forecasts is the same one that value investors routinely follow: Do I have a view (i.e., a variant perception) that significantly differs from the target group's conventional wisdom? If so, what asset class prices will be affected when these views

are reconciled? And what catalyst(s) will bring this reconciliation about, over what time frame?

On the quantitative front, researchers have found that some early warning indicators of major regime changes may exist, apart from changes in the VIX and other market volatility indicators that are commonly monitored by investors (and which tend to be more coincident rather than leading indicators of uncertainty spikes). In “Early-Warning Signals for Critical Transitions”, Scheffer, Bascompte, Brock and their fellow authors concluded that “complex dynamical systems, ranging from ecosystems to financial markets and the climate, can have tipping points at which a sudden shift to a contrasting dynamical regime may occur. Although predicting such critical points before they are reached is extremely difficult, work in different scientific fields is now suggesting the existence of generic early-warning signals that may indicate for a wide class of systems if a critical threshold is approaching.”

The authors highlight two potential indicators. “The most important clues that have been suggested as indicators of whether a system is getting close to a critical threshold are related to a phenomenon known in dynamical systems theory as ‘critical slowing down’...As the system approaches a critical point, it becomes increasingly slow in recovering from small perturbations...Analysis of various models show that such slowing down typically starts far from the critical point, and that recovery rates decrease smoothly to zero as the critical point is approached and reached...One important prediction is that the slowing down should lead to an increase in the autocorrelation in the resulting pattern of fluctuations; because slowing down causes the intrinsic rate of change in the system to decrease, the state of the system at any given moment becomes more like its past state.” In this regard, one particularly worrying indicator has been the progressive slowing down of the rate at which employment has recovered from recent U.S. recessions (80-82, 90-91, 01-02, and 07 to today). While financial market prices have responded more rapidly, post-downturn employment recovery seems to be a much better indicator of the fundamental health of the political-economic system. And for almost 30 years, it has been sending increasingly worrying signals.

The second indicator of an approaching critical point highlighted by the authors is increasing skewness (i.e., the asymmetry of fluctuations). “This does not result from critical slowing down. Instead, the explanation is that at the critical point, the unstable equilibrium that marks the border of the basin of attraction [for the new regime] approaches from one side...As a result, the system will tend to stay in the vicinity of the unstable point for longer than it would on the opposite side of the stable equilibrium.” Two other researchers, Guttal and Jayaprakash, have also recently found that “changes in the asymmetry of the distribution of time series data, quantified by changing skewness, is a model-independent and reliable early warning signal for regime shifts caused by both increased external fluctuations or decreased internal resiliency” (see “Changing Skewness: An Early Warning Signal of Regime Shifts in Ecosystems”).

While these indicators promise to be helpful in forecasting regime shifts and spikes in uncertainty, the fact remains that such predictions are currently extremely difficult to make with a degree of accuracy significantly beyond luck. The inescapable conclusion is that the key to superior investment performance is therefore superior adaptability rather than superior forecasting skill. This is also the conclusion of a very interesting new book by David Alberts ([The Agility Imperative](#)), that will soon be published by the Command and Control Research Program of the U.S. Department of Defense. Alberts opens with a provocative statement: “We are still thinking and acting as if we are in the Information Age. However, this label no longer provides an accurate description of the characteristics of our time. More importantly, Information Age mindsets and solutions cannot adequately address the challenges of the 21<sup>st</sup> century. A more appropriate label for the world we live in is The Age of Interactions. The technologies of the Information Age and the application of these technologies have, since the arrival of ubiquitous connectivity, evolved from providing limited access information processing applications to enabling an explosion of rich [network] interactions...The Information Age has provided us with increased access to vast amounts of data...It has held out the promise of reducing uncertainty to manageable levels and consequently improving our ability to make decisions. Under some

conditions, and for a select set of problems and tasks, this promise has indeed been realized. But the new technologies and capabilities of the Information Age have, in addition to solving one set of problems, created the conditions that have led to a new set of problems. The increased access to information... has also enabled richer, more continuous interaction between and among individuals and organizations. Thus the same technologies designed to reduce uncertainty by creating and disseminating information have enabled real-time interactions never before imagined. As a result, events that may once have had isolated consequences can now generate cascades of consequences that can quickly spin out of control. This is the reality of our times..."

"Prediction is not possible... Both a new mindset and problem solving strategy is required. The most promising approach is to increase agility – the ability to effectively cope with rapid change...Being agile involves the ability to create an adequate understanding (awareness) of the environment and the ability to anticipate and/or detect and recognize a relevant change in circumstances. Being agile also requires the ability to respond appropriately, by acting in a timely manner or, indeed, by not acting...Agile people conceive and approach the world and their assigned tasks differently from those who are less agile. In general, agile people have a propensity to seek improvements, and are more willing to consider information that is at odds with preconceived notions [e.g., actively seek information that disconfirms their hypotheses], and are more willing to be different and take risks...It is possible to observe agile behavior or a lack of Agility only in hindsight...Agility is a latent property, a potential that remains dormant until it is manifested and its power realized. This presents difficulty for those who wish to make investment decisions based upon a definitive determination of the value of Agility...Robustness, flexibility and resilience all contribute to Agility, yet we limit these by not making them central to investment decisions and/or by placing significant constraints on individual and organizational behaviors."

In their paper ("Warning: Physics Envy May Be Hazardous to Your Wealth!"), Lo and Mueller also offer some suggestions for coping with a world in which uncertainty shocks are an integral and inevitable aspect of a system. They note that, "a successful

application of quantitative methods to modeling any phenomenon requires a clear understanding of the level of uncertainty involved...The failure of quantitative models in economics and finance is almost always attributable to a mismatch between the level of uncertainty and the methods used to model it...An important ingredient in the successful implementation of any model is recognizing the boundaries of its validity.” More concretely, they observe that “there are two responses to the recognition that, in the face of Level-4 or Level-5 uncertainty [see the first part of this series in last month’s issue for a definition of these terms], a model is outside of its domain of validity. The first is to develop a deeper understanding of what is going on and to build a better model [for examples of the benefits which can result from this, see “The Virtues and Vices of Equilibrium and the Future of Financial Economics” by Farmer and Geanakoplos, “Top-Down versus Bottom-Up Macroeconomics” by Paul DeGrauwe, and “Financial Factors in Economic Fluctuations” by Christiano, Motto and Rostagno]. The second response to recognition that a model is outside its domain of validity is to admit ignorance and protect the portfolio by limiting the damage that the model could potentially do [e.g., stop loss orders, put options, position limits, allocations to volatility, etc.]...This brings us to risk management, which is the heart of investment management...A complete risk management protocol must contain risk models, but should also account for model risk – the tradeoff between making a decision when the model is wrong, and not making a decision when the model is right.” We have previously written about another approach to this issue, emphasizing the findings of Francois Hemez and his colleagues from Sandia National Laboratories on the inescapable trade-offs between a model’s fidelity to historical data, its robustness to uncertainty, and the confidence one should have in its predictions (see, for example, “Breaking the Myth of Predictive Modeling” by A.M. Singh). We have also frequently reported on the growing body of research that shows how confidence in prediction can be increased by combining the forecasts of models made using different underlying methodologies (see, for example, the recently published paper “Forecast Combinations” by Aiolfi, Capitstran and Timmerman).

Finally, James Montier (who is now at GMO) recently published a research white paper that calls for “a return to investing basics” in order to cope with a more volatile and uncertain environment (“I Want to Break Free, or, Strategic Asset Allocation Does Not Equal Static Asset Allocation”). He begins by noting that “in the beginning there was the idea of investment – straightforward, unconstrained investment. It was a simpler, happier time, when the essence of investment was to seek out value; to buy what was cheap with a margin of safety. Investors could move up and down the capital structure as they saw fit. If nothing fit the criteria for investing, then cash was the default option. But all of that changed with the rise of modern portfolio theory, and, not coincidentally, the rise of professional investment managers and consultants [and their obsession with comparative performance measurement].” Montier offers three criticisms of what has become the conventional wisdom with respect to “professional” investment management. We have also made these points quite a few times over the past fourteen years.

1. “Risk isn’t volatility.” Rather, “risk is the danger of a permanent loss of capital.” Montier notes that this “can come about for three reasons: (1) valuation risk – you pay too much for an asset; (2) business risk – there are fundamental problems with the asset you are buying; and (3) financing risk – leverage.”
2. Strategic asset allocation ignores valuation changes.
3. Performance benchmarking alters investment manager behavior in important ways, including promoting a focus on relative rather than absolute returns. As Montier notes, “Keynes’ edict that ‘it is better for reputation to fail conventionally than to succeed unconventionally’ governs the day.” Performance benchmarking also causes investment managers “to ignore the endogenous nature of risk...Investors alter the returns they are likely to receive when they all chase after the same investments [Montier cites private equity as an example].”

Montier calls for a “return to a simpler, but more holistic approach to investing... Clients should liaise with their managers to set a realistic real return target...Having defined the target, managers should be given as much discretion as possible to deliver that real return, to avoid the benchmark hugging behavior that is typically induced by [static strategic asset allocations].” We have frequently noted the underappreciated importance of Montier’s first point – whether one’s goal is achieving a long-term real portfolio return target or beating an external benchmark has an extremely important impact on investor behavior. And we have also frequently noted the importance of allowing for deviations from long-term asset class allocation targets as valuations change (and the particular importance of avoiding dangerous overvaluations and the extremely damaging losses that follow them).

Montier also notes that successful implementation of a valuation-sensitive strategic asset allocation policy requires patience, “as valuations are only mean-reverting over relatively long periods of time...A willingness to be contrarian is also vital. You will inherently be doing the opposite of what everyone else regards as sensible. Being a contrarian involves three separate elements: (1) Having the courage to stand against the dominant view; (2) Being an independent thinker; and (3) Having the firmness of character to stick to your guns. All three of these traits are unnatural in human beings! ... Provided that one can be patient and contrarian...changing your strategic asset allocation in response to the fluctuating opportunity set offered by Mr. Market [i.e., in response to valuation changes] seems like common sense to me. Sadly, of course, common sense tends to count for little in the world of high finance...” To that, all we can add is a heartfelt “Amen!”

So where does this leave us? As investors, we must learn to distinguish between risk – (randomness which can be made understandable through the use of probability or statistics) and uncertainty (randomness which can only be made understandable through the construction of an inevitably flawed mental model). We must be conscious of the powerful emotional and potential behavior impact of spikes in our perceived uncertainty. We must recognize that powerful forces, both within ourselves and within the networks of which we are a part, are guaranteed to generate



these uncertainty spikes. The good news is that there are some early warning indicators we can use to detect – albeit weakly – signals of future spikes in uncertainty. That said, we must also recognize the limitations of these forecasting techniques, and acknowledge that agility – e.g., a willingness to adjust our asset allocation weights in light of surprising developments and valuation changes – rather than prediction is our best hope for protecting our portfolios when uncertainty jumps. There are also habits of mind – such as seeking disconfirming evidence, combining forecasts, and focusing on robustness as well as efficiency – that can help to insulate us from the worst emotional effects of uncertainty spikes. Finally, given the inevitability of surprising transitions into what we have termed the “High Uncertainty Regime”, we also need to be willing to put in place portfolio defense measures – such as stop losses, long-dated deeply out of the money put options, and allocations to a wide range of asset classes, including volatility – well ahead of when they are needed, when the cost of doing so is cheap. We cannot escape uncertainty spikes. What we can do is increase the probability of achieving our long-term goals by learning to cope with these scary episodes better than other investors.