Long-Term Risks -- Estimation and Management

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Abstract

Financial economics theory and models have primarily focused on a short-term horizon. Rational expectations and financial economics grew up in the context of a capital market, addressing issues relevant to decision-making by those active in those markets, typically dominated by short-term financial instruments. Subsequent to these developments, an increasing number of papers and theories have developed the field of behavioral economics, recognizing that not all such participants act in a strictly rational manner.

Although these themes and theories have proven helpful to those with exposure to short-term risks, they have not satisfactorily addressed the needs of those involved in longer-term obligations, such as actuaries involved in insurance and pension programs. Actuaries have dealt with such risks through the use of risk mitigation techniques such as asset/liability management and product features that spread these risks through risk transfer, pooling, diversification and offsetting.

This paper develops principles that underlay these risks, methods of mitigating the effect of these risks and methods of monitoring, regulating and reporting on them.

Keywords

Long-term risks, risk management, actuarial, insurance, pension
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Background and scope

A great deal of finance literature has focused on a relatively short time horizon (usually less than a year and sometimes for far less than that). Over this time horizon, it deals primarily with the risk associated with volatility of future cash flows and corresponding values. In contrast, actuarial practice deals with both short-term and long-term risks, with a focus on illiquid obligations for which market prices are not readily observable. As a result, actuarial practice has evolved somewhat differently than finance, significantly relying upon actuarial judgment and risk management techniques.

Although this paper does not find that the cost of a long-term risk is necessarily greater than that for short-term risks, it demonstrates that they are different in character and thus need to be addressed in a different manner. In this process, the applicable mitigation approaches that can be used have almost been as important as the risks involved themselves.

Because the types of risks and uncertainties that actuaries deal with vary significantly by the type and timing of the rights and obligations involved, they cannot easily be addressed in a comprehensive manner in a paper like this. It should be kept in mind that the perspectives, resources and character of the stakeholders involved differ by their very nature, even when they relate to the same rights and obligations. Indeed, it has to be recognized that the generalizations noted here are only that, and do not necessarily apply to the individual situation or stakeholder. Nonetheless, independent of perspective, risks do differ in terms of their time dimension. Their recognition, measurement and mitigation depend on the knowledge and experience involved, and the extent and the effect of the conditions that can change over time.
How long-term risks differ from risks of the short-term

Although a superficial comparison may lead to a conclusion that, since short-term and long-term aspects of certain risks share similar characteristics, the associated risks should also be similar. Upon further reflection, however, it can be seen that the difference in time horizon involved can change their basic nature.

For example, short-term and long-term mortality risks in the insurance business share many characteristics, in particular relating to the insured event and the use of pools of similar risks to manage them. However, when assessing those risks from a long-term perspective, the effect of factors including: adverse selection from wearing off initial underwriting selection resulting in part from aging of the insureds and her/his behavior due to voluntary lapsation of the better insurance risks, changes in medical treatment and technology, unexpected pandemics, and changes in the prevalence of smoking and obesity, the risks associated with mortality over a long-term period have to be greater than that of mortality in the next year. Similar factors affect pools of personal automobile insurance, including changes in car safety, car usage and aging of the insured; however, a significant difference between short-term and long-term automobile insurance risks is that the automobile insurer has the annual opportunity of re-underwriting and re-pricing their risks. This opportunity also is key difference between the character of the long-term risks of mortality and automobile insurance.

In finance, the assessment of uncertainty has tended to be short-term in perspective, dominated by volatility, that is, fluctuations around the current expected value, consistent with a capital markets approach. But as found out during the Global Financial Crisis, volatility should not be the only thing of concern, particularly when multiple risks are involved, as it was shown that such factors as the effect of correlations between credit and liquidity risks in tail situations can dramatically effect economies and can change quickly.

The expected value of the types of risk involved during short-term or long-term periods is influenced by the extent of knowledge about the risks in the first place and the experience data available, whether developed on the basis of recent experience or some other source, as well as the perceived potential for change. These may be a function of the significant drivers of the contingent event addressed. A few examples of these differences follow:

- Mortality/longevity. Observed experience data with respect to the mortality experience for a large existing pool of insured lives provides some comfort that the expected value of mortality for that pool in the near future may reasonably be estimable. Over the short-term, with the benefit of the effect of the law of large numbers, the short-term uncertainty associated with this portfolio may be limited, although the possibility of volatility still exists, particularly as a result of change in the size or composition of the portfolio. This same portfolio, however, has an inherently larger long term risk, as overall mortality improvement and the degree of adverse selection of terminators from the pool affect long-term results.
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- Property damage. Due in part to changes in the condition of the property, its owner and the neighborhood of the property, the expected value of property damage over the long-term can be difficult to assess in advance. This is one reason why insurance coverage for losses due to property damage is usually short-term in nature. This potential change in the characteristics of the property and its owner is a prime reason why premiums can change and contracts can be terminated on an annual basis. Nonetheless because the likelihood of a quickly developing extreme event, such as an earthquake, may be either the same or quite different, depending of the circumstances involved. Risks associated with more gradual change, such as the change in condition of the neighborhood or property or climate change, can be reflected in re-rating and policy termination, if deemed appropriate.

- Financial instrument/loan default (credit risk). The default risk for financial instruments and loans often increases over time, as these instruments are usually subject only to an initial underwriting screen and differential pricing based upon assessed credit risk. As time goes on, credit quality tends to disperse and in fact to deteriorate on the whole, particularly if there is an opportunity for the financial instrument/loan to be repaid on a voluntary basis in the interim, if contractually permitted. Whether an immediate default is imminent can usually be forecasted, resulting in a greater degree of risk as the duration of the bond increases.

Long-term risks can in some cases be viewed in terms of the aggregate effect of a series of short-term risks. If this is the case, the risks in each period can then be serially correlated, since they are not independent of each other and are contingent and not independent upon earlier ones as well. As such, the nature of their aggregation can differ from what they would be if they stood on their own in an independent manner.

Long-term risks generated from the pressure generated from demographic, human behavior, climate change and economic power shifts seem unstoppable, unless their probable effects are identified and effectively managed far in advance. Their effects can build quietly over time and represent factors that can significantly affect long-term cash flows. Unintended consequences of any decision effective for the longer-term should be assessed.

Systemic risks have to be considered in the assessment and management of any participant in a financial system, in that entities by their very nature and business model put themselves in harm's way of such risks. In contrast, entity-based risks, those that affect only the entity as a result of its decisions and actions, e.g., the underwriting and marketing processes they used to select the risks undertaken. Although systemic risks are system-wide and by their very nature are more difficult to control than entity-specific risks, the risk management process has to be applied to both, albeit in some cases through different approaches. Both types of risks and their effects can be present over both the short-term and long-term.

Some factors have a short-, intermediate- or long-term equilibrium or maximum/minimum value. For example, (1) assuming that current monetary objectives of certain
jurisdictions expressed in terms of a specific or small range of values are met, long-term inflation should tend to converge at about those values, (2) nominal interest rates tend to be related to inflation expectations and are usually subject to minimum and maximum probable values, (3) mortality improvement has tended to change with its fundamental drivers, including the lagged effect of technological and human behavior (e.g., smoking) changes. Nevertheless, although it feels like there should be current, or at least ultimate, equilibrium values in most cases, these can be difficult to estimate, and changes in conditions can change the equilibrium value from time to time.

Many cash flow series and drivers of these cash flows are subject to cycles and patterns. In some cases, they can be short-term in nature, e.g., seasonality patterns. Cycles are primarily longer-term, including business, investment, inventory and underwriting cycles. Where identified and a basis for their projection exists, actuaries take observations of their effects can be reflected in their estimation processes. For example, Joseph Schumpeter expressed his analysis in terms of several different cycles, e.g., Kondratieff long waves of 45-60 years, 8-11 year Juglars and 40 month Kitchin cycles, all of whom are difficult to predict with any precision. Depending on the situation, these patterns and cycles can be more or less predictable, although, for the short-term actions may be able to be taken to offset their effect and for the long-term average values over a period covering one or more full cycles may be used in longer-term projections.

Effective short-term risk management involving cyclical risks would ideally include the identification of turning points, while longer-term uncertainty can in some cases be reduced through the use of (1) long-term historical trends over one or more full cycles to estimate future values or (2) average values over one or more cycles. Similarly, the combination of bubbles and their subsequent bursts can affect the valuation of assets and liabilities in one or both ways, although because of their extreme effects their average may prove an unreliable estimator of long-term results. Bubbles/bursts can be the result of multiple factors, including systematic overconfidence (or level of uncertainty) on the part of buyers or the cumulative imbalance of supply and demand over time.

In insurance an analogy is the underwriting cycle, in which hard and soft markets alternate, i.e., prices increase as competition becomes a less important factor, which leads to marketplace competitors becoming more aggressive to gain market share and the inevitable price drop. These cycles are often quite difficult to ride out, especially in a price sensitive market in which distribution relationships can at best be temporarily lost or if the entity is highly leveraged. In addition, in some cases it can even be difficult to tell where in the cycle you are, let alone figure out when the next turning point will be.

In the short-term, the risks of a new entrant or crazy/naïve participant in the market can result in prices that are outside the acceptable range of more experienced participants (often being due to a loss leader or aggressive underpricing to gain market or distribution share). Not following these leading prices may result in loss of market share if the market is price-sensitive, even if in the long-term those market players cannot stay in the market, either due to loss recognition or a return to rational pricing. So, assuming that new loss-leader type competition does not arise immediately after the exit of the
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retrenchment of the prior price leader, an entity's business model and marketing strategy may have to be adaptive to such changes in circumstances.

Although shock risks (caused by ‘black swan’ or other discontinuities in underlying factors) can affect results in either the short- or long-term period, early warnings for the long-term period may be identifiable currently or at an early period prior to their emergence. If identified or anticipated in sufficient time, possibly due to provision for concentration risk or in response to limitations as a result of application of the entity’s risk appetite, effective adaptive action to offset its effect might already have been taken, while if a relevant risk management technique had previously been put into effect, its potential adverse effect may already have been mitigated. The farther in the future unknown-unknown risks emerge allows more time to apply mitigation tools to the risk. In summary, although either a one-time sudden system shock or an entity-specific shock (e.g., a run-on-the-bank type scenario) can occur at any time, early identification or dynamic risk management processes should be expected to reduce its effect on the entity in the long-term, with a lower incidence in the future (this only means that fewer unknown-unknowns should occur in the immediate future, as most such risks should already be known). Nevertheless, it is worth noting that certain risks, such as those that contributed to the 2007-2009 Global Financial Crisis, snuck up unbeknownst to many, but far from all people.

Approach to the estimation of long-term risks

Intuitively, it seems impossible to estimate things that may occur in the distant future. Who could possibly have estimated (that is, guessed) the Global Financial Crisis precisely thirty years ago? Looking back thirty years, I doubt if could have predicted all or even most of the technological, demographic, economic and financial changes that have occurred and their impact on the risks that I as an actuary addressed then.

In fact, in some cases it is not as difficult as it would first seem. Let's take a look at a few of what might be considered to be some of the more difficult expected risk factors or cash flows.

- U.S. health care costs. Twenty years ago I served on a technical panel for U.S. social insurance programs that consisted of actuaries and economists. The panel, assisted by government staff, evaluated aggregate health care costs, excess medical inflation, expected demographic shifts, the insatiable demand for health care and economic capacity. The projected health care cost percentage of GDP was remarkably prescient, in part because the then recent trends pushed the limits of credibility as there had to be some capacity limits that could never be exceeded (e.g., more than 100% of GDP devoted to health care). The year-to-year fluctuations would have been difficult, if not impossible to predict.

- Long-term mortality and life expectancy. Sixty years ago, U.S. annuity projection tables developed for use in valuation of annuities reflected continued mortality improvements. Although it didn't predict specific related contributors to
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subsequent actual experience, such as HIV/AIDS, blood pressure treatments and the change in smoking habits, those long term prediction factors were not that far off. We'll see if future mortality projections are that accurate.

- Inflationary effect on future insurance contract unit costs. Recognizing the broad relationship between inflationary effects on operating costs of insurance companies, the huge increase in renewal expenses for life insurance companies over the past forty years have been more than offset by investment earnings in excess of what was then expected. Nevertheless, if looked at in isolation, the projections back have not proved particularly good.

- Equity earnings and wage inflation. Over the post World War II period, the massive run-up of equity prices in many countries provided more than adequate returns to pension programs to compensate for increases in wages and benefit formulas. Unfortunately, even decades-long historical experience doesn't translate to experience in all future periods, as has been seen lately.

In each of these cases, the estimation of expected cash flows and quantification of long-term risks can depend on the circumstances involved and the application to which these estimates are made. For example, they may be developed for compliance with a financial reporting standard, to determine a dividend scale for participating insurance contracts, to recommend funding levels for a defined benefit pension program or for input to political decision making in a once-in-a-decade-or-three change in taxation and retirement requirements for a social insurance scheme.

In addressing such long-dated obligations, actuarial practice has often taken a conservative (prudent) approach. In fact, this represents a clear distinction between actuarial practice in its assessment and measurement of long-term risks, such as those contained in many insurance contracts and pension obligations, and those areas of finance where short-term risks (e.g., less than six months) have dominated. An example of this conservatism has been the almost universal use of a mortality improvement factor for more than forty years for payout annuities in many countries, such as the U.S., while generally not reflecting mortality improvement for similar purposes for life insurance.

This willingness to take on long-term risks as a result of using conservative approaches (as we will see, not only by use of conservative assumptions but use of implicit and explicit risk management approaches) is a key reason why insurers and pension programs have been the dominant sources of long-term funds in the world. This willingness to invest in such long-dated financial contracts is also due to the utilization of risk mitigation techniques described in the next section of this paper.

In part this conservative approach has been taken because of concern about the possible adverse implications to the sponsors and beneficiaries of the contracts or programs of getting estimates wrong. In the extreme case, this failure would result in an inability to fulfill promises made to policyholders of insurance contracts or pension beneficiaries.
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A significant future application will likely be the use of a current (prospective) value of liabilities for insurance contracts as reported in general purpose financial statements, as currently being discussed by the International Accounting Standards Board (IASB). Such a prospective approach is discussed in a research paper prepared by the International Actuarial Association (IAA)1. This paper does not suggest that the prospective approach described is the only one possible; nevertheless, it is indicative of an actuarial approach that is not 'conservative' in nature, although it does describe possible approaches to inclusion of an adjustment for risk. Similar to the building block approach expected to be applied by the IASB in the measurement of liabilities for insurance contracts (IFRS 4) and for general liabilities (IAS 37), the measurement of obligations by means of estimation of its expected cash flows, discount to present value and an adjustment for risk.

Considerable discussion concerning the accounting objective for a risk (undifferentiated between short-term and long-term risks) adjustment has been held in crafting the proposed financial reporting framework for insurance contracts by the IASB. Some have felt that risk and uncertainty have been adequately recognized by incorporating expected (mean) cash flows. In my opinion such an expected value does not fully reflect the uncertainty of such a contract.

Just like in a statistics 101 class, almost at the same time a student learns that a probability distribution can be applied to determine an expected value (mean), the student also learns that all of the moments of the applicable probability distribution need to be considered to fully understand the risks to which the probability distribution applies. For example, its second moment, i.e., in terms of its variance or standard deviation, should be considered, as should its third (skewness) and greater moments, particularly when an asymmetric distribution is applicable (as is the case in most long-dated risks). In addition to its statistical properties, the risk aversion of an entity or participants in a market may be incorporated in a value-based measurement objective (whether calibrated to market prices in a fair value or to other calibration measures)2.

Several actuarial techniques have been developed to quantify risk and uncertainty. These include, among others, (1) a cost of capital method, which some view as a practical surrogate for the value of inherent uncertainty, while others believe is the capital markets or regulator’s required cost of being in the risk business, (2) a quantile method that is designed to reflect a quantile of risk, as measured in a Conditional Tail Expectation, TailVar or more simplistic confidence level approach, expressed in terms of either (a) the aggregate expected total cash flows over the applicable period or (b) each of the assumption drivers of risk separately, such as for an insurance contract’s mortality, policyholder behavior, investment return and expense risks, and (3) a probabilistic approach directly applying each moment of the applicable probability distributions.

The IAA paper devotes a chapter to the effects of risk mitigation techniques on risk margins. This is due to the many opportunities for both risk taking and risk management that have emerged over the past century (or more in some cases). Some of the more important recent developments involving these techniques relate to (1) increasingly
Many markets have relatively standardized traded financial instruments, e.g., in stocks and bonds. Active markets have not been developed for many of the more complex instruments (now traded over-the-counter) and insurance contracts (primarily only re-purchased on a business combination basis), the latter of which consists of a bundle of insurance, service and financial components. In part, this has been due to the complex nature of the long-term obligations involved. Due to the lack of adequate market price measures, actuarial present values remain the predominant method of measurement of the risks involved (whether or not carried out by actuaries).

Historical cost-based values that do not consider possible future scenarios and their corresponding probabilities of occurrence are generally not appropriate for the measurement of long-term obligations and rights. For longer-term risks, it was Winston Churchill who said “The longer you can look back, the farther you can look forward.” History and long-term observations are indeed helpful in deriving reasonable assumptions. For instance, in assessing many long-term risks, it can be desirable to observe at least the most recent full business or underwriting cycle, while understanding the effect and timing of the metric involved over more cycles, at least to the extent relevant to expected future experience. Generally the longer the observations the better, as long as they reasonably relate to the current or expected future conditions.

Similarly, the use of set-and-forget assumptions without adaptive measurement mechanisms and management that doesn't actively manage its risks is doomed to failure over the long-term, unless the assumptions used turn out well, the risk mitigation tools prove effective as planned, or if just lucky. Most people simply cannot project the future well enough to reduce the speculative nature of undertaking long-term obligations and rights; they typically extrapolate from current conditions. To enable reasonable estimates to be made of the effect of long-term risks, regular reviews of the assumptions made, as well as management approaches taken, are needed. I am impressed, but not yet convinced, by the optimistic views expressed by those who think that they can do it any other way.

Nevertheless, the effects of long-term risks are not necessarily greater than that of short-term risks. For example, when measured from the date of loss or accident of many property & casualty insurance contracts, the risk of incurred but not reported claims is usually far greater immediately after the loss or accident date than later on. Similarly, immediately after a claim is reported to an insurer, only limited information is usually available regarding the individual claim, resulting in a high degree of uncertainty regarding that claim; as further information becomes available, that uncertainty tends to decrease. For a life insurance contract with a heavy savings component, the net amount at risk tends to decrease, even though the uncertainty with respect to mortality rates at longer contract durations generally increase over time.
Economic theory indicates that a current equilibrium value should exist for many factors affecting the risk, if not the subject risk itself. If a shock to the system does not occur in the meantime, the value of the item measured will tend to move toward that equilibrium value over time. Although almost inevitably this value tends to be overshot, at least at the first pass, over a long time period that equilibrium value, if does remain the equilibrium value, may serve as a good long-term average estimate for the item.

This long-term equilibrium concept is inherent in the 'reversion to the mean' approach that is based on the assertion that, over the long-term, there is an 'ultimate' value of an economic item that can be estimated based on the long-term historical experience for the item (e.g., equity return and inflation). The estimate until the ultimate period is reached usually begins with the current value, moving toward this ultimate value over a 'select' period, e.g., five years. In addition, it might incorporate the assumption that the values during this select period that would otherwise be interpolated will be offset by a correspondingly opposite change (compared with the interpolated value) in a succeeding period (e.g. if the long-term mean assumption is 8%, then the actual value of the item in the current period of 4% will be offset by a 12% estimated result in the next period), as over the long-term, the cumulative effect of the interpolated and ultimate values is still expected to be achieved. Of course, the equilibrium value or underlying mean is often the most difficult input to this process, although historical experience is usually used, for a given historical period used as the base for estimating the long-term mean (e.g., over a 10 year period it might be 4% while over a 20 year period it might be 10%).

In any case, some variables may not have an equilibrium mean, at least one that will not be reached for a very long time or for which a reliable estimate cannot be derived. In contrast to most products and services, not all assets and obligations are equilibrium seeking, e.g., if the system is unstable, is subject to extreme variability and if there are multiple possible regimes and it is uncertain which, if any, is a reasonable ultimate regime under which to determine an estimate. For example, if asset values increase, then wealth increases, which can in turn encourage increased debt that will increase the money supply, which in turn can increase demand for the types of asset in question, that will then likely result in an increase in their prices; this process holds in reverse for liabilities.

The effect of the time value of money becomes more important in assessing risks over the longer term. Although this doesn't change the cost of the risks involved, it does affect the current value of those risks, thus affecting the price charged and the willingness of purchasers to pay for it. It also puts more pressure on the determination of discount rates used in any valuation.

In developing estimates, risks might equivalently be expressed as a function of time (i.e., in the discount rates) or as a function of the actual cash flows or risks. For a capital market product or debt, they are often expressed in terms of a number of basis points of discount rates, primarily as a result of historical practice and for convenience, although it is known that credit risk events are more often back-loaded in the future, that is, a credit risk event for an entity in the more distant rather than the short-term future. In areas such as insurance contracts and pension programs, they may more appropriately be expressed
in terms of the expected costs or risks involved, for which an equal allocation over time may not be appropriate.

The application of a simple lattice-type model is generally better suited for shorter-term risks. For many longer-term risks, such a model can become quite complicated, not only because of the multiple assumptions involved, the lack of symmetry of most longer-term risks and the likelihood that the probabilities involved will change over time, but also without reasonable caps and floors on the assumptions the range of probabilities can quickly get out of control.

Market-consistent values, derived from observed prices in transactions in a reliable market from the sale of relevant items, have been used to derive a current assessment of the aggregate consensus of the participants in that market. The value for certain risks derived from these observations may be more reliable than the judgment of a single individual at a given point in time, in that it is derived based on an aggregate consensus of those participating in that market and, at least according to the efficient market theory, such prices should fully incorporate the most recently available information (although recently this theory has been questioned). Where such observations are not available, a model is used to estimate these values. The fair value is result of whichever approach is used.

While the market is not always 'right' and the stipulation that such values be used, sometimes referred to as the dictatorship of the market, such values can be useful if the objective of the measurement is to compare these values with other current measures within an entity, across entities within an industry and even across industries. This is a value-based measure and as such incorporates information about risk and the price market participants are currently willing to either buy or sell the item. In any case, such values may serve as a basis to reflect the long-term expectation of risk and uncertainty. The extent that the market over or undervalues the risks involved (and various markets have been known to overreact to circumstances) can bias the results relative to the entity's expectation. Nevertheless, active markets have historically been sensitive to known risks, e.g., the market priced credit risk and sub-prime based mortgage securities in the last several years better than many who were outside markets.

Significant correlation between the effects of underlying drivers of expected cash flows should be considered. When components of the expected cash flows are correlated with each other or when the aggregate or individual components of the expected cash flows are correlated with outside variables, say economy performance or systemic mortality trends risk, the relevant variables should be considered simultaneously. Although the correlation between the effects of the risks should not be ignored in any projection (and can vary over time and under different conditions, especially in the case of a tail risk event under an illiquidity condition), their relationships should be reflected in an appropriate manner.

Due in part to the stochastic nature of the future, stochastic methods can be used to consider the effect of a range of possible expected cash flows, especially valuable if they
are asymmetric in nature or effect, to reflect the stochastic processes underlying the expected future. The methods used can differ, possibly significantly. For example, determining the stochastic effect of uncertainty in a single period is relatively simple and straightforward. However, the stochastic effect over a longer-term period can be reflected through measurement techniques including nested stochastic methods. It is not the intent of this paper to discuss the relative advantages of these methods. Nevertheless, for longer-term risks, it is important to understand and reflect the expected cumulative uncertainty, e.g., whether the uncertainty is exponentially expanding, or is more controlled, for example through caps and floors and reversion to a mean.

Tail risks (the concentration of risks under relatively extreme circumstances) can occur either in the short- or long-term future, although they may be more likely to emerge over a longer period of time. The adaptive and dynamic mechanisms utilized may be able to prevent or mitigate some of the risks over the longer term (see the next section for further discussion; an example is the institution of earthquake standards for new and/or retrofitting existing buildings that will reduce the financial effect of a future earthquake, although it will be relatively ineffective the year after enactment). This time horizon can be important for those risks that don't emerge without warning (e.g., certain pandemic risks or certain natural disasters) or that emerge gradually over time (e.g., gradual changes in human behavior or evolutionary drug improvements). An often-quoted story of the frog in a pot of water may be relevant -- if the water is boiling when the frog is placed in the pot, the frog will jump out immediately and save itself, while if the water temperature is only gradually increased, the frog might stay in the pot and die a boiling death.

In most cases, the lack of sustainability is a long-term risk to be avoided. Therefore, an important financial reporting concern is whether an entity should be assumed to be a going concern; in many financial reporting systems, this is assessed over the next twelve months, although this type of short-term measure is rarely appropriate. Longer term measures are needed.

A conceptual approach to testing the solvency of certain enterprises described in many early actuarial papers involved ruin theory, addressing the probability that an entity or business segment had negative surplus at a given point in time in the future. This was shown to be inadequate for many purposes, due to: (1) if a significant credit impairment condition emerges at an intermediate point, it may never be given the opportunity to recover to a more favorable result at the pre-designated end point and (2) attention is needed not only to the probability of survival, but also the amount of ruin. Thus, end point survival, although possibly of theoretical interest, is not sufficient for most purposes, with sustainability of both the system in which the business operates and of the business model itself being more important.

Risk mitigation and risk management

Can long-term guarantees and participant options be provided on a sound basis under expected conditions involving significant risk and uncertainty? On the surface, such
provisions are likely to represent potentially costly risks – for example, how can, for example, an insurer provide protection against mortality or incorporate in its premiums the inflationary effect on servicing expenses over fifty years at a currently derived price? Yet this has been done by insurance companies worldwide in one way or another for far more than a century.

Taking advantage of the law of large numbers for these long-term risks by having a large size pool of similar risks is involved may not be sufficient, even though short-term fluctuations may be minimized. In most cases, pooling isn't enough to address the uncertainties involved over a long-term period, as, useful in taking advantage of a large number of risks, it is only one contributor to the reduction in uncertainty and volatility. In many cases a greater part of the risk involved is whether one can reasonably estimate the mean or degree of asymmetry involved. This greater level of risk can only be overcome through use of effective risk management approaches and techniques.

Risk management is a process, consisting of a toolkit of useful approaches to identify, assess, avoid, take on, manage, monitor and reassess the risks involved. A comprehensive approach to risk management is desirable in many instances, as it tends to increase risk transparency and to reduce the silo effect that manifests itself in many organizations, thus reducing duplication and identifying holes in identifying and addressing risks. An important example of such an approach that has recently emerged is Enterprise Risk Management (ERM), that seeks to ensure that all significant risks of an entity are identified and effectively managed, embedded throughout an organization.

An important characteristic of ERM, particularly important is addressing long-term risks, is the application of feedback loops, such as incorporated in an actuarial control cycle, a flexible approach that provides regular management feedback loops potentially covering all aspects of the decision-making process. These are especially useful, as unanticipated changes in conditions are common and the feedback cycle addresses discrepancies between the estimation models applied and observed developments.

Although risk management usually focuses on the control or reduction in risk, it has to be emphasized that profits can be generated by taking advantage of risk-related opportunities, no matter how risk averse one is. The reward for taking on risk and taking advantage of risk opportunities, can be the primary method of making money. In most cases, however, a control of this risk taking is the only way to successfully maintain a sound long-term strategy.

Risk and uncertainty over the long-term is ever-changing by their very nature. The only effective way to respond to this characteristic of risk is with corresponding risk mitigation tools. The degree of discretion needed in applying these tools will depend on the particular tool applied. Risk management can take place before an adverse event, coincidental to the event or after the event, the method of which needs to be determined.

Although the following risk mitigation techniques can be applied to both short-term and long-term risks, most are particularly effective approaches to the management of long-
term risks. A comprehensive risk management process can utilize multiple techniques. And of course, they cannot all be used to address a particular type of risk. The following is one categorization of these techniques.

1. Risk avoidance. Although avoidance can be applied over a short-term period, not being placed in a position to be exposed to risk can also be a useful strategy over the long-term, although it can limit opportunities at the same time. In some cases it can be difficult to avoid risk once taken on, even in what was thought to be a pass-through function. The entity’s risk appetite, resources or available capital may not be appropriate or sufficient to cover all available risks, so a strategy of avoidance can be of strategic or tactical importance.

Nevertheless, ultimately it may prove to be unsuccessful if, for example, a counter-party was used to avoid the risk, or if a legal, regulatory or judicial constraint intervened. Certain reinsurance or securitization techniques should be fully examined before being satisfied that all risks have not been kept; nevertheless this is a useful strategy to consider in some cases.

a. Risk limitation. The use of this technique places a maximum exposure on a particular type of risk, thus being a form of risk avoidance. For example, by limiting the amount of sales of a particular capital-eating product during a period, limiting the amount ceded to a reinsurer or net exposure to another type of counter-party or type of invested asset, certain concentration risks can be capped.

2. Risk sharing. Risks can be shared or spread among different portfolios or entities, e.g., through insurance pooling and profit/loss sharing. Slicing and dicing risks, that is, into tranches, does not eliminate risk; rather, it simply spreads it differently. Those who believe that they hold the safest tranche, as has been seen recently in the Global Financial Crisis of 2007-2010, can be just as affected by tail risk as if the risk had not been tranched. Risks can also be shared, as is the case with deductibles and participating contracts, between the sponsoring entity and its policyholders.

3. Risk transfer. This is similar to risk sharing, but the transferor remains ultimately responsible for the risk. Approaches that have been used include reinsurance and securitization, although (except for assumption reinsurance, which is in essence a sale of the business) it has to be realized that a counter-party risk may result if not structured properly with this in mind. Although variable annuities (unit-linked products) also include certain guarantees, all or most of these contracts' direct investment risk can be transferred back to the policyholders.

4. Product or obligation features. This source of mitigation feature can combine 2) and 3). Contracts with these features include management options and discretionary charges and fees, including non-guaranteed cost of insurance and expense charges, and provision of investment returns in excess of that guaranteed. The increase in cash values in a whole life insurance contract effectively reduces the mortality risk in later
contract durations of this type of contract. Risk bundling within a contract can also be viewed as one form of risk aggregation. Policyholder bonuses and dividends are also a result of such features. Insurance contracts are examples of risk bundling that can effectively reduce the risk of a single component. Usually risks can only be shared to the extent provided in the contract; in a limited number of cases, a retrospective charge to the policyowner can be made when excess losses arise, such as in the case of an assessment mutual insurer. The typical long-term risks involved with insurance contracts are those involving experience factors, including investment return, which have generally been addressed with conservative interest rate guarantees or passing the risk back to the policyholders, and policyholder behavior, participating dividends/bonuses and surrender charges in certain products.

5. Conservative pricing/underwriting. In fact, anything that can increase the expected profitability of a contract can also increase the ability of an entity to deal with long-term risks. Flexibility, usually incorporated through a contract feature as described in 4), includes any source of increasing rates or charges upon adverse experience. For example, for U.S. (state renewable) health insurance, if filed with the regulatory authority, increases in rates or even contract termination (except in the case of a guaranteed renewable basis), as long as it is done on a portfolio and not on an individual contract basis, can be accomplished.

6. Risk diversification. Two or more risks whose effects have correlation coefficients less than one can provide some diversification benefit, with the smaller the coefficient the larger the potential diversification effect. In most short-term applications, diversification assumption can be reflected as a risk mitigation technique across portfolios. When two risks are perfectly negatively correlated (correlation coefficient of negative one), they can be considered to be offsetting, such as the mortality risk of life insurance and longevity risk of payout annuities for the same insureds.

Over a long-term period there can also be diversification over time. When a risk is positively correlated over time, that is, the probabilities of events are similar if not identical in different time intervals, taking on that risk over time tends to reduce the risk compared with taking on the risk in single time intervals separately.

7. Risk aggregation. Diversification can also be achieved by combining, or aggregating, risks, for example, across business segments and contract components. For example, the bundling of risks in an insurance contract in effect can reduce the risk associated with taking on each of the components separately, in addition to reducing associated expenses compared to they would have been issued separately. This aggregation can operate over several types of risk groupings, depending on the situation, including entities, lines of business or portfolios within an entity or even between the components within a contract.

8. Risk hedging. Hedging of risks arises when the effects of more than one risk have correlation coefficients less than positive one. Perfect hedging involves taking on additional risks (or a financial instrument, such as a derivative) that completely
offsets/matches the original risk. Such a hedge might be able to be constructed in relation to the cash flows involved (a cash flow hedge). Although it may be possible to establish a perfect hedge over a short time horizon, such a technique may not work as well over longer horizons. An example is the use of inflation-sensitive government bonds (in the U.S., Treasury Inflation-Protected Securities) to hedge against similar inflation risks.

Hedging does not have to be 'perfect', as many variations of hedging exist, e.g., macro-hedging, in which hedging is conducted on a portfolio or business segment basis in which the cash flows from a portfolio are managed on an overall basis, such as with interest rates. Another less-than-perfect hedge is a catastrophe bond, which compensates a certain amount up to the principle of the bond if a specified catastrophe occurs, even if it does not match in amount or timing of the losses incurred by the seller of the bond. Other examples are mortality/longevity bonds in which there may be a strong yet not perfect hedge.

It can be difficult to ascertain the inflation-hedging properties of many assets, particularly over the long-term. Hedging can be provided for through the use of derivatives; nevertheless, investment in derivatives, especially those that are complex, tailored and not traded on a market, can be risky and used for purely speculative purposes if they are held naked (i.e., not accompanied with the corresponding item theoretically being hedged).

The extent of effectiveness (perfection) of a given hedge reflects not only the degree of matching of the expected value of the applicable cash flows or values, but also the extent of uncertainty involved (through the 'greeks'). Hedging values can be accomplished through the development of a replicating portfolio (the development of an actual replication portfolio can be difficult, as well as demanding dynamic updating over time).

In defined benefit pension plans it has sometimes been assumed that equity returns can serve as a hedge against inflation (or wage growth) risk. However, although this has been demonstrated to work adequately over many periods, it certainly hasn't worked over all periods. To develop a hedge, first the risks to be hedged need to be carefully specified, for example, whether a hedge against inflation or changes in wages is needed, and how the unhedged portion should be managed by other means. In addition, correlations of the effects of multiple sources or components of cash flows may not be sufficient to develop an adequate hedging program, as what was highly correlated historically may not always be in the future.

9. Conservative capital. Adequate capital or funding can help to provide for adverse experience developments. A recent demand of banking regulators has been to increase the amount and quality of minimum surplus; similar pressures exist for insurers. However, these additional amounts may prove insufficient to provide for extreme events; for this reason it would be valuable to have some form of contingent or back-up funding for such cases. Unfortunately, those times of need are precisely
the time during which external funding sources, be they banks or the capital markets, can also prove inadequate for this purpose.

a. Raising future capital. This approach to assume that capital can be raised as the need arises, rather than ensuring that the current level of capital will always be adequate, has been shown to only be effective in ‘good’ times, precisely when it isn’t needed.

10. Asset/Liability Management (ALM). A common approach used by financial institutions, including insurers, is to manage the cash flows associated with their assets together with the cash flows associated with their liabilities through an ALM process. Expected cash flows, as well as in some cases their uncertainty characteristics, are either effectively matched to reduce the investment risk (e.g., pre-payment and reinvestment risks) or the entity is willing to take on the residual risk. In an ALM process, the positive cash flows from assets are matched, to the extent possible, to the cash flows from corresponding liabilities.

ALM is not easy to successfully apply, as constant rebalancing may be needed. It benefits from multi-disciplinary analysis and discussion, particularly between those involved in actuarial and investment functions. Other issues may be involved; for example, relating to longer term risks, in some jurisdictions the longest available financial instrument in the open capital markets is shorter than the longest expected liability cash flow. Thus, reinvestment risk still remains. Banks can make money when they deliberately mismatch their assets and liabilities: the cash flows for their assets are longer than the cash flows for their liabilities, at least when the yield curve is not inverted, that is the case the majority of time.

11. Enterprise Risk Management (ERM). This is a comprehensive process of risk assessment and risk management. Through this process, emerging and siloed risks and their correlations can be addressed. In addition, an effective ERM process, at least once a risk management culture is embedded throughout the organization, can continue to be emphasized; nevertheless, even a Toyota, a company known for its high quality can falter if higher market share is over-emphasized.

12. Growth. Growth in a company is not usually recognized as a risk management technique. Nevertheless, soundly based growth can overcome several risks, for example, a high level of fixed costs (e.g., overcoming an economies of scale risk) and ability to utilize expensive resources (e.g., expensive technology). For example, when I just started in the insurance business, the expected maintenance/renewal overhead expense level per inforce insurance policy was between $5 and $10; now it can be ten to twenty times that level, depending on the company. For those policies sold then that remain inforce, the cost overrun measured on a per policy basis is significant; however, because of policy terminations and the growth achieved by most companies, the effect of this long-term cost overrun is relatively minor in most companies. However, growth cannot by itself overcome other problems, such as inadequate prices or lack of other risk management techniques.
Some of these techniques incorporate action by the insurer from contracts outside the domain of the contract being assessed, or even a pool of similar contracts. In addition, the dynamic nature of many of these techniques can match the dynamic nature and experience of the corresponding obligations. To keep the insurance enterprise on a sound and stable footing over the long-term, there is little to say in favor of static (set-and-forget) modeling, assumptions or strategies. Depending upon the actual risk, dynamic systems (e.g., ALM, adaptive pricing and capital allocation, and discretionary management options) need to be utilized or be able to be utilized, especially under adverse conditions.

Specific longer-term risk mitigation approaches:

- Can be built into the risk-generating item itself. For example, for a participating life insurance contract, the provision for sharing the risk between insurer and policyholder is inherent in the contract, and for the holder of a corporate bond, general or industry-specific economic growth or inflation can reduce expected default costs.

- Can be dynamic in nature, particularly when discretionary action is available to be used. However, there may be constraints to ensure that this discretion can be utilized. For instance, by common practice, certain hedges or loans have been assumed to be rolled over without any problem; however, as was seen in the Global Financial Crisis of 2007-2010, liquidity risks could make this difficult if not impossible to accomplish in all cases when needed.

- In some cases if the systemic issue or problem is significant enough, it might be assumed that systemic forces will be applied to reduced its effects, e.g., if an AIDS-type epidemic became significant, one would expect that resources that otherwise would have been devoted to, say, heart disease, would be transferred to AIDS research, in which case AIDS would more likely be contained. Another example is that if the costs of medical malpractice tripled, sufficient pressure might build to focus political attention on tort reform.

- Many trends, even those that are seemingly spiraling out of control, reverse themselves eventually, either sooner or later. For example, the million+% inflation in Zimbabwe was eventually reduced and the dot.com stock (share) bubble eventually burst.

In the development of decision-useful information regarding long-term projections, it is important to thoroughly assess the effect of risks and the risk management tools that are available and have a high credulity that they can be applied without significant unintended consequences. The types of consequences can differ depending on whether possible adverse consequences are due to systemic risks (that all participants in the system will be subject to and thus less likely to have individual adverse consequences, such as significant decreases in interest rates -- all competitors will have to react in a similar way) or entity-specific risks (for which that company's competitors might be able to take advantage of).
Specific shorter-term risk mitigation approaches are usually more straightforward and easier to apply than longer-term ones, in that there are likely to be fewer intervening or less complications involved, unless a black swan or discontinuity arises, simple extrapolation might be used, with some limitation, that even short-term risks can have a significant, yet more likely less thick tail (less skewness).

A significant element to successful risk management is a receptive governance structure, regular risk monitoring and disclosures to applicable decision-makers and stakeholders. The chance of the risk management governance process to be of high quality is increased as the Board (as a whole or through a committee focused on risk management) and the CEO gets involved. The strategic governance of risk should address the types and extent of risks the company is exposed to, as well as the mitigation tools that are available.

Back-testing can often be used to monitor short-term risks (although of course, just because an occurrence happens but was given a 10% probability or is a one in a hundred year event, does not necessarily imply that this was a good estimate). Back-testing is more useful in a high frequency, short-term situation. In contrast, back-testing cannot so easily be performed on a long-term risk (e.g., for global warming), although observations over one or more long term historical periods, if relevant and reliable data are available, should be considered. Ensuring that external risk management disclosures are consistent with internal management measures used (the ‘use test’) is importance in providing effect risk management information to financial reporting users.

Although risk management usually focuses on the control or reduction in risk, it has to be remembered that taking on risk can be a primary method of making profits by taking advantage of risk opportunities. However, good governance would indicate that these situations, if material, should be taken only when the risks involved are fully understood and if practical are quantified. In many cases, however, a control of this risk-taking can be important to take on risk on a long-term basis.

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3 For further discussion of stochastic methods, see *Stochastic Modeling: Theory and Reality from an Actuarial Perspective* (2010) International Actuarial Association