Stochastic Projections of the Financial Experience of Social Security Programs: Issues, Limitations and Alternatives

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This paper has been produced by the Social Security Committee of the IAA and has been approved by that committee.

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Introduction

For well over a century, actuaries have projected the financial experience of social security programs around the world. Policymakers – and actuaries themselves – have debated various aspects of these financial projections, such as: (a) the key economic and demographic assumptions, including mortality improvement and fertility trends, on which the projections are based, (b) the duration of the projections, which have ranged from just a few years to 75 or more years, and (c) the treatment of uncertainty by deterministic and stochastic methods. This paper focuses on this last aspect, highlighting key issues related to the application of stochastic models, although the paper also touches on the first two aspects due to their interrelated nature.

Types of models

An actuarial projection of a social security program is not a prediction, but rather a forecast based on a selected set of assumptions. All models are simplified representations of the future, with their resulting projections being estimates that involve uncertainty, as no important aspect of future experience can be known with certainty. They can be used to project future experience to provide useful financial information for policy decision-making.

A "deterministic" projection is the output of a model that applies a single set of assumptions regarding the values of important variables to represent future experience. These deterministic assumptions are applied to the initial state of the program expressed in terms of its demographic and economic characteristics, such as the composition of the current population and the economic condition of a country, which to a large extent is known. These assumptions can be expressed in terms of “best-estimate” or as a set of values that represent one or a combination of possible future scenarios.

A "stochastic" model is one in which at least one significant economic or demographic variable is assumed to vary in a stochastic (or probabilistic) manner. In these models, the future path of these variables is treated as uncertain; they depend on the random (or seemingly random) behavior of these variables. A full stochastic model, as the name implies, is a model in which all important and interesting economic and demographic variables are stochastic and should be treated in that manner. The increased use of stochastic models has been made possible by significant increases in computer power.

Forecasts produced by stochastic models have been incorporated in a variety of ways into reports of social security programs in several countries, such as the United States and Canada. These have usually supplemented the forecasts produced by deterministic models. This use of stochastic models has facilitated expanded approaches to further analyze social security programs, although the challenges and limitations of their use, as noted below, are important considerations in their use.

An approach to determine the financial condition of a social security program’s financing by means of either type of model with respect to its expected benefits is to discount to the present its expected future cash flows, although the expected cash flows by calendar period are also useful indicators of its future financial condition. This methodology is reasonably well understood by most policymakers, although their presentation alone may not adequately describe the implications of the uncertainties over the long-term period needed to properly assess a social security program.

Although there are differences, stochastic and deterministic modeling approaches have far more in common, including the data used, base estimates (whether referred to as best, central or expected values), and projection periods. Differences are primarily due to the stochastic model's need for (1) probability distributions of individual or groups of variables or of the projection as a whole, (2) their interrelationships and (3) random number generators. The approach taken to communicate results can be similar or different.

Some important variables are "uninteresting" in a stochastic sense because a variation in their value does not significantly affect the resulting projection or is expected to remain relatively stable over time. An example is retirement ages in the U.S. social security program, where the present value of benefits beginning at different possible retirement ages is relatively stable as a result of actuarial reduction and increase factors applied if retirement occurs before or after normal retirement age, respectively.

Models and uncertainty

Actuaries are well placed and qualified to make social security projections, having experience in developing practical models that consider the quantification of the effects of risk and uncertainty.

The assumed probability distributions for the variables in these models are intended to represent the risk (volatility) around a central estimate, the extent of uncertainty associated with the amount or trend in the variable being analyzed, or both. Although both risk and uncertainty should be considered, the uncertainty associated with the long-term periods over which the financial condition of a social security program is usually the dominant reason for stochastic projections.

The starting point for both deterministic and stochastic models is an assessment of past experience and current conditions. Expectations regarding the future usually evolve over time as knowledge evolves and changes occur in factors expected to drive the socio-economic environment, as well as in law, regulation and administrative practices. With this in mind, the actuary determines the extent that past experience should be adjusted for the purpose of developing projections.

The extent and types of risk and uncertainty relating to future values and trends are important in developing and understanding these projections. Risk and uncertainty can affect input variables and resulting projections in several ways. Values and trends affect and in turn are affected by current as well as expected future conditions. How today's situation relates to applicable cycles and fluctuations in experience can affect the interpretation of the initial state with respect to many key input variables and may point to the need for subsequent adjustments. In addition, short-term fluctuations in a specific variable in a future time period may not significantly affect the best estimate or the probability distribution of the aggregate level or trend in long-term projections. However, that said if fundamental demographic or economic forces are affected by for example, the great recession of 2007-2009, they should not be ignored.

In certain cases, an estimate of a probability distribution may be better based on experience over a longer period than is needed for developing a deterministic (best) estimate of that variable. This is especially the case for those variables for which recent experience may be more relevant to use for developing a deterministic estimate than earlier experience, such as for fertility or inflation rates. Due to changes in cultural values, fertility rates of more than a couple of decades ago may be irrelevant to fertility rate projections.

Another example is when a monetary regime with a new inflation target (or that is expected to be more or less tolerant of deviations from these targets) was introduced five years ago. It is reasonable to expect that economic experience for the past five years is more relevant than that prior to the recent period. In contrast, other than experience during the transition period between monetary regimes, the historical deviations from before and after the target changed may be used to develop a probability distribution for this experience.

A new or significantly revised social security program presents particular measurement challenges, as relevant performance information may be limited. In this case appropriate disclosure regarding this type of uncertainty and what would likely be a wider probability distribution would be appropriate.

The development of a projection of future experience should not be a mechanical process. Analysis of reasons why the past experience of every important assumption in a deterministic or stochastic model is not expected to be representative of the future needs to be made and its conclusions documented. In addition, stochastic and probability tools have to be appropriately applied, including the use of an effective random number generator and applicable probability distributions, whether of a symmetric or asymmetric nature (the degree of asymmetry assumed will likely depend on the risks involved and the significance of the shape of the distributions). It should also be kept in mind that the application of too many complex variables in these models can produce a perception of spurious accuracy and a loss of control of the model building process, which both the modeler and users should be aware of.

Central assumptions and associated distributions

The historical mean of a variable, like price inflation or mortality rate trend, may not be an actuary's best estimate of the variable used as an input to a social security projection. Examples include price inflation due to a change in a monetary authority's objective such as the one described above or mortality rate trend as a result of a recent breakthrough in cancer treatment and an earlier reduction in cigarette smoking.

A separate set of considerations may influence the selection of each assumption. For example, as mentioned above, it is quite difficult to reflect the frequency and severity of possible long-term or severe shocks such as periods like the Financial Crisis of 2007-09 and the Japanese "lost decades", and the enormous long-term changes in workforce composition, fertility and longevity.

Financial projections for such programs have traditionally placed greater emphasis on the best estimate or expected value of the assumed probability distributions for important variables, rather than the extremes of those distributions. Not only is setting the mean or central assumption for variables like inflation or mortality trends difficult, but projecting the distribution of that variable going forward also represents a challenge. Different considerations may influence the selection of the distribution about the mean, in part because of differences in confidence in how the future will differ from the past. Results can also be sensitive to equation specification, degrees of interdependence among variables and the historical periods used as a base from which the estimates are made. However, having to think about appropriate distributions may also enhance the rigor applied to develop best estimates.

For instance, how can the fact that annual price inflation exceeded 4 percent in twelve of the previous sixty years be reflected in estimating the probability of annual price inflation exceeding 4 percent in any of the next thirty or sixty years? As a result of this uncertainty, users of projection information should be informed as to the uncertainties in the best estimates and in the limitations of the models that produced the financial projections.

These problems can increase in magnitude as the length of the projection period increases. As an example of the most extreme case possible, in 2003 the United States government began publishing for its Social Security program so-called “infinite-horizon” projections, using a deterministic model. At that time, the American Academy of Actuaries (U.S.) criticized the results as practically meaningless for policymakers, as well as potentially misleading. It is impossible to predict in a reasonable manner over such a time horizon through either a deterministic or a stochastic model. Nevertheless, the direction in expected benefits and contributions near the end of a reasonably long projection period, say seventy five years can provide a useful indicator of the effect of expected long-term trends and certain policy alternatives.

In many cases the probability is relatively small that important but stable variables like mortality rates in a large country will vary dramatically from one year to the next. For a projection covering five to ten years, some actuaries can have a reasonable (if not high) degree of confidence regarding the range of future experience and even the probabilities of various outcomes within that range. But for very long-term projections, say 30, 50, or 75 years, not only is the trend in income and outgo uncertain, but as the range of projected values widens the value added by the range decreases. For that reason the projection and range should be periodically revisited to reflect emerging experience.

The results of stochastic models, run hundreds or thousands of times, will certainly differ. By ordering all of the runs in some meaningful way, probability distributions of the overall results are obtained. The outcome of these runs can indicate that the current value of a social security program is, for example, “no more than X with a 95 percent probability”. Likewise, stochastic models can provide information such as the probability that, given the current contribution and benefit rates and the current assets, the funds of a social security program will run out by, say, 2030.

For both deterministic and stochastic models the rule of “garbage in, garbage out” applies. No model, however refined or sophisticated, can be better than its input data and assumptions. Progress in the capacity to construct and manage large data bases, however, should provide actuaries with more reliable information and better capability to analyze inter-relations of variables that is a major challenge for stochastic modeling. A challenge associated with long-term social security projections remains that the uncertainty increases as the projections extend decades into the future.

Setting aside the technical issues associated with estimates made over extremely long projection periods, the willingness of policymakers responsible for a social security program to base short-term decisions on projections over such a long period usually declines with the length of the period, as politicians often over-focus on the short-term. Because it is difficult to get some decision-makers to even look at the long-term, it is important that the basis of assumptions in both deterministic and stochastic models be disclosed in a transparent manner. Whether policymakers want, need or can meaningfully apply such probabilities to policymaking decisions is an open question, the answer to which will vary from country to country.

Issues associated with the assumptions, the choice of the projection period and the inherent uncertainty associated with long-term demographic and economic conditions and trends apply to both deterministic and stochastic models. The use of probability distributions for stochastic models, however, can make a transparent and effective disclosure more challenging than for deterministic models.

Stochastic modeling used to measure uncertainty

Stochastic modeling is particularly useful in assessing and illustrating the uncertainty associated with social security projections. The International Actuarial Association's book entitled *Stochastic Modeling: Theory and Reality from an Actuarial Perspective* (2010) discusses the uses of stochastic (versus deterministic) modeling. It provides a description of a particular application of stochastic modeling in the following:

> ***When analyzing extreme outcomes or "tail risks" that are not well understood***
> Scenarios intended to represent one-in-100-year events or one-in-1,000-year events are typically used to stress-test asset or liability portfolios. In some cases, such as a "Black Tuesday" stock market event, the modeler may even believe that he or she has a handle on the likelihood of an extreme event. But recent experience has proved differently in many cases. How many would have included the "perfect storm" scenario of low interest rates and low equity returns of the early 2000s or an event that could cause the catastrophic losses of the World Trade Center terrorist attack? How many would have contemplated the 2008/2009 credit crisis that has affected the United States and European markets? Stochastic modeling would likely have revealed these scenarios, even if indicating they were extremely unlikely.
>
> Yet financial risks are among the best understood risks with which actuaries deal. Mortality and morbidity risks are often much more complex, especially when considering the scope of assessing pandemic risk such as the 1918 Spanish flu event. Such an event could represent a 1-in-1,000 event, or it might not. Insufficient frequency [of] data, rapidly evolving healthcare technology, and increasing globalization could alter the likelihood of a contemporary pandemic and call into question the credibility of using a few select stress scenarios to understand the true exposure. Another approach would be to develop a stochastic model that relies on a few

well-understood parameters and is appropriately calibrated for the risk manager's intended modeling purpose.

Although social security programs are not normally subject to large short-term financial tail risks, they can be subject to several long-term tail risks and sources of uncertainty. Due to the size of many social security programs, the probability distributions for many assumptions over the short-term can have a smaller statistical variance than in many other actuarial applications, that is, assuming recent experience is available and reliable these assumptions should normally experience smaller fluctuations from expected levels in the immediate future. Nevertheless, due to calamity risk, such as the Spanish influenza epidemic of 1919 or war risk in many countries, such variables can still contain significant uncertainty, even over the immediate term.

A greater tail risk for social security programs can arise due to the length of the projection period, for example, as a result of significant changes in a country's economy such as hyperinflation and stagflation, as well as changes in demographic and other variables such as advances in medical technology, health care costs and societal factors such as fertility rates. The latter can be seen in the huge worldwide decrease in fertility rates over the last several decades. In addition, some countries continued significant expansion in life expectancy at a rate consistent with trends observed in the last several decades could also be considered to be a tail risk. In addition to expected economic and demographic risks, there may be other exposures to risk, such as changes in natural conditions, including flood or earthquake risk (as in Japan in 2011) that can be severe in certain countries.

An important distinction between most social security programs and private programs is that when a nation encounters significant adverse or significant favorable changes, there is usually adequate time to change the social security programs in response. In contrast, such changes cannot be made in many insurance policies in which benefits are guaranteed under its contractual terms or in employer-sponsored pension plans in which terms are in employment terms and conditions. However, it has to be recognized that reductions in benefits or increases in contributions in social security programs can be difficult to implement due to social and political pressures, and that it can take a long time for such changes to be made in response to long-term factors. As a result it can be difficult to anticipate the timing and extent of the response to any adverse conditions and trends.

The use of stochastic models may not be the best approach in all circumstances

The IAA book indicates several conditions in which stochastic modeling may not be appropriate:

> ***When should use of stochastic models be questioned?***
> In still other cases, stochastic modeling may not be of sufficient value to justify the effort. Examples include:
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> ▪ **When it is difficult or impossible to determine the appropriate probability distribution**
> The normal or lognormal distributions are commonly used for many stochastic projections because of their relative ease of use. However, there are times when these distributions do not properly describe the process under review. In these situations a distribution should not be forced onto the variable. Indeed, there are many other distributions available as described in other parts of this book; the analysis of which distribution best describes the available information is a critical part of the overall modeling exercise. However, there are still times when it is impossible to determine the appropriate distribution.
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> ▪ **When it is difficult or impossible to calibrate the model**
> Calibration requires either credible historical experience or observable conditions that provide insight on model inputs. If neither is available, the model cannot be fully calibrated and the actuary should carefully consider whether its use is appropriate. Sometimes, an actuary is required to develop a model when no credible, observable data exists. Such a situation requires professional actuarial judgment and the lack of data on which to calibrate the model should be carefully considered.
>
> ▪ **When it is difficult or impossible to validate the model**
> Stochastic models are less reliable if the model output cannot be thoroughly reviewed, comprehended, and compared to expectations. If the actuary must use a model from which the output cannot be reviewed and validated, professional actuarial judgment is required and other methods of review and checking should perhaps be considered. The method of review and checking will necessarily involve a careful consideration of the specifics of the situation.

It can be challenging to develop a forecast of any variable over the long time horizon of a social security projection, especially considering the uncertainty inherent in the demographic and economic experience involved. The use of probability distributions and covariances between the variables in a stochastic model adds to that challenge. Changes in the program, cultural values, technology and the economy over long periods further weaken the link between the past and the future. As a result it is difficult to estimate the effect of changes in the future, both regarding expected values, their probability distributions and their interrelations. This also applies to the difficultly in calibrating, let alone validating the accuracy of a model predicting a variable, say, thirty years in the future or an estimate made thirty years ago, than a short-term forecast of unemployment made one month earlier.

Taking a straightforward example, a deterministic model might assume a level 3 percent annual price inflation over the projection period or 5 percent for the next 10 years decreasing linearly to 3 percent over the following 30 years. We know that this will not actually happen, as there will be significant variability in the rate over time -- including the possibility of deflation or a spike into hyper-inflation, however unlikely it may currently appear. A corresponding stochastic model not only has to incorporate this assumption, but also the variation in this rate and the relationship between, say, price inflation and invested asset returns (where the program modeled holds assets). Based on information available at the time of the projection, it has to be decided whether the estimates of the expected value and degree of uncertainty vary over time or remain constant.

Of course, some of these questions are also relevant to a deterministic model. It could be asserted that the range of likely inflation rate outcomes is easier to estimate than is the expected value of the inflation rate over the long-term period. In any case however, the number of assumptions needed and complexity is greater in a stochastic model. Although some believe that the more variables or characteristics of the distributions assumed (e.g., means versus means and probability distributions) will naturally make the projections more uncertain, it is really the degree of confidence the actuary or user places on key assumptions made that is more important.

Relating to the reliability of assumptions, the IAA's book indicates on page I-5:

> ***Uses of inappropriate distributions or parameters***
> Users of stochastic modeling often assume – blindly or with very limited empirical evidence – that a variable has a particular distribution. While many processes can approximate a normal distribution, more often than not the possible outcomes are skewed. Users of stochastic modeling should be cautioned against the uninformed use of a particular distribution, which can generate scenarios producing completely useless results. Such a misguided assumption can be especially problematic when examining tail risk.

It can be easy for a user of these projections to be led to believe that since a probability distribution has been developed, it is "right". Because of their apparent greater technical sophistication and reflection of future uncertainties, stochastic models tend to be favored by certain developers and users of their projections over deterministic ones, with the result that projections from stochastic models might be given a greater degree of acceptability. In fact, as mentioned above, not only is the mean of the distribution subject to uncertainty, but the distribution itself and thus the range derived from it is as well. However, it is false to conclude that a stochastic projection necessarily involves more uncertainty. In addition, because a stand-alone deterministic projection leaves the underlying uncertainty of its possible or probable range of values unaddressed, it potentially provides a perception of greater certainty, while the stochastic projection can reduce that uncertainty since the distribution of results shown can emphasize and help quantify the uncertainty.

The expected value for most demographic variables over the short-term is usually more certain than over the long-term. This is because these variables over the short term are not usually subject to as many changes or shocks compared to the initial state as they are subject to over a long-term period that may not reveal themselves for many years. For example, although fertility rates can vary from year to year, their deviation from initial state to its level several decades later can be significant, with a significant effect on long-term social security program projections. In contrast, although short-term fluctuations in some economic variables can be large, owing to cyclical patterns often experienced in these variables, aggregate long-term experience or trends may be more predictable.

Short-term analysis of a social security program can also be important. While many projections of social security programs cover long periods of time, policy makers are also frequently interested in short-term projections, for instance for budgetary purposes and to assess its claims paying ability (for liquidity or cash management purposes) when funding is conducted at a level close to a pay-as-you-go basis. In this case an analysis of recent short-term forecast errors can be of significant value. In this case statistical fluctuations and stochastic analysis can prove more important than the quantification of long-term uncertainty. In this case validations are easier to perform than when attempting to test the validity of long-term forecasts.

Covariances

Some deterministic models assume that the variables used are either independent of each other or have been constructed including a fixed interrelationship among the variables implicitly incorporated in their estimation. In a similar manner, many stochastic models not only assume this independence or interrelation with the means of the variables, but also assume that the probability distribution of one variable does not affect the probability distribution of others. This is equivalent to assuming there is no covariance (or that the covariance equals zero) between the variables. In reality, such an implicit assumption is not always realistic.

Some variables are related to each other in ways that are reasonably well understood – or at least observed. Interest rates and inflation rates, for instance, are positively correlated because inflationary expectations are usually a component of corresponding interest rates. Wage growth and price inflation are similarly positively correlated, although perhaps to a smaller degree. Such relationships can be empirically demonstrated to exist; nevertheless, expressing them mathematically in a way that holds true under differing conditions can be challenging. In addition, whether past relationships can be expected to be representative of future ones is problematic in many situations.

As a result, the projection of the effect of these relationships and covariances represents yet another significant challenge using both deterministic and stochastic models. Examples include the quantification of the relationship between interest rates, inflation rates and economic growth, and the more subtle relationship between recent / near-term fertility rates and longer-term real economic growth, with resulting differences in the number of future workers and productivity. Estimating the uncertainty associated with these relationships and future covariances between key assumptions can be a significant challenge. Many deterministic and stochastic models avoid this difficulty by explicitly assuming that their variables are not related and that all covariances are zero.

Such a lack of explicit conversion assumptions can represent a limitation of stochastic models, although it should be noted that deterministic models can similarly suffer if the interrelation between variables over time aren't recognized.

Additional approaches to describe uncertainty

Most of the limitations of stochastic models relate to inappropriate or inadequate assumptions. If the assumptions used are reasonable, their resulting projections can be quite useful in assessing the uncertainty involved. They can also be used in other ways; for example, to help calibrate sensitivity, stress and tail-event tests for social security programs. An example of an effective application can be found in the 2010 actuarial report on the Canada Pension Plan in which the authors indicated that “The results should be interpreted with caution and a full understanding of the inherent limitations of stochastic time-series modeling.” In this report the effect of financial market tail events were assessed through the use of a stochastic technique.

At the same time, policymakers need to understand that any model, especially one involving long-term projections, has limitations and its projections will not come true exactly as presented. In any case, it is highly desirable to have some sense of the potential uncertainty associated with the projection. For example, if a deterministic model projects an unfunded liability of US$6 trillion (approximately the value in 2011 for the United States' Social Security program over the next 75 years), does this mean that we are 95 percent confident that the "true" figure is within 10 percent? Or is the range something like plus or minus 50 percent?

Another approach used for many years for some social security programs has been to produce three deterministic projections, sometimes referred to as low-cost, best estimate and high-cost estimates, where the low-cost and high-cost projections are intended to represent possible variations of likely future experience. It is important to clearly indicate that experience outside of that range, although unlikely, is possible. Thus the estimates should not be interpreted as minimum or maximum possible values. The assumptions used to develop this range usually include factoring subjective basis relying on professional judgment. A limitation of this approach is that sometime it does not provide users information necessary to assess the likelihood of different outcomes, although they may describe a reasonable range that provides some sense of the uncertainties involved.

Such a three-projection analytical approach is equivalent to selecting three points of a probability distribution. The results of a stochastic model can be used to develop a more informed range of individual parameters or aggregate projection range, rather than the low-cost and high-cost values being selected totally through judgment. While an actuary cannot identify which of many possible futures will materialize, extreme values can in many cases be ruled out, reducing the range of scenarios shown. This approach may reduce the likelihood that a decision maker will pursue an impossible dream or be overly pessimistic.

Another way to indicate the degree of uncertainty involved is to perform so-called "sensitivity analysis", where the central set of assumptions is initially used repeatedly, but one (or perhaps more than one) key assumption is allowed to vary at a time, within a reasonable range of values. This demonstrates the sensitivity of the projections to changes in important variables. However, sensitivity testing can have some of the same shortcomings as do stochastic projections, e.g., it can be difficult to set a reasonable range over a long-term period, and the interrelationship between and among assumptions are sometimes ignored.

A related approach to sensitivity analysis is referred to as "stress testing", seeking values of input assumptions at a tail or adverse level. By solving for the degree of a given level of stress to a certain driver of experience, even if not currently plausible, a projection can be made to achieve a specified adverse outcome. For instance, a projection might be developed with decreased levels of real earnings growth relative to prices until the projection shows that contributions beginning in a certain year need to be increased beyond a certain level for the social security program to maintain a given financial condition.

When projecting alternative scenarios in which multiple assumptions are assumed to vary, it is desirable where practical to develop and reflect assumptions, either implicit or explicit, regarding these interrelations. In fact, when variables are strongly related, it may be misleading to analyze the sensitivity of one of these variables alone.

Using both alternative scenarios and sensitivity analysis can provide useful information. This avoids the danger that alternative scenarios may be seen as having certain and possibly spurious probabilities associated with them. In contrast, a stochastic projection, through the use of many possible outcomes that are not pre-selected and thus not subject to possible bias, may better convey the uncertainty of the uncertainty. While the actuary cannot pinpoint which of the many potential futures will materialize, in many cases extremely improbable results can be rejected, thus reducing the range of uncertainties. These projection tools can provide the user with better insight as to the uncertainties involved and can lead to an improved design where uncertainties are better controlled.

Conclusion

With the technical and computational ability to design and run models of social security programs, the actuary has a responsibility to create and communicate projections in a number of different ways. Models, whether deterministic or stochastic in nature, need to be developed and managed in a responsible manner, with the use of soundly based assumptions that are based upon sound actuarial principles and practice and that are clearly described and documented. It is always necessary to effectively communicate to policymakers and others not only the base projections but also the uncertainties and limitations of using such tools in laymen’s language. The social security actuary should ensure that the deterministic or stochastic models and the corresponding assumptions used are reasonable and make the best use of professional experience, skill and judgment.

Actuaries need to be careful not to become overconfident when taking advantage of the capabilities of their computer models and should evaluate the reasonableness of the results of any projection model. Depending on the assumptions used, stochastic models, scenario analysis, sensitivity analysis and tail analysis can provide useful insight in the analysis and description of the uncertainties and their sources in the long-term projections of social security programs.

It is important that actuaries inform users of their financial projections of the uncertainty inherent in them through these approaches. The use of stochastic models can provide further insight into the uncertainties and possible consequences of decisions, although particular care is needed because of the additional complexity that results from the need to use the distribution of and interrelationships (covariances) between the variables estimated. With the complexity and advanced capabilities of today's models, the actuary's judgment has never been more important and critical in advising policymakers.