SOCIETY OF ACTUARIES Investment Section

Risks & Rewards

ISSUE 57 FEBRUARY 2011

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Are Genetic Algorithms Even Applicable to Actuaries?

By Ben Wadsley

Several professional fields are currently using Genetic Algorithms for different applications. Genetic Algorithms are being used to plan airplane routes,[1] develop equity market bidding strategies,[2] point antennae on military vehicles,[3] optimize an iterative prisoner's dilemma strategy,[4] and even work toward developing Artificial Intelligence.[5] While these applications are very useful to other professions—and quite interesting to study—they don't seem to have anything to do with Actuaries. As I was being introduced to the idea of Genetic Algorithms through the Forecasting and Futurism Section of the SOA, my main question was, "If these people are so successful in using Genetic Algorithms, why can't Actuaries?"

This essay intends to answer the question "Are Genetic Algorithms Even Applicable to Actuaries?" by first walking through the example of "Robby the Robot" as derived from the example in Melanie Mitchell's Complexity, A Guided Tour.[6] Also, I will look at what characteristics of this application are useful and then apply those characteristics to an example based on my use of this technique to solve a life insurance ALM problem. The goal is not only to describe one use of Genetic Algorithms, but also to help the reader explore this thought experiment and discover how Genetic Algorithms can be expanded to solve many other actuarial problems.

WHAT IS A GENETIC ALGORITHM?

There are many different varieties of corn—some that are wind resistant and some that produce many ears of corn. The objective of a seed corn company is to breed the two types of corn to hopefully develop a variety of corn that both produces a lot of corn and is wind resistant. This is the exact idea that is being leveraged with the use of Genetic Algorithms—except instead of corn we are breeding computer programs and investment strategies.

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CHAIRPERSON'S CORNER

As I write this we are fresh off the heels of the Investment Section Council's annual face-to-face meeting that precedes the SOA Annual Meeting. I always enjoy the opportunity to see, in person, the members of the section council and SOA staff that mostly work by phone and e-mail during the year. We also get to meet the newly elected council members just starting their terms who bring with them new perspectives, and have the opportunity to casually discuss a wide variety of topics.

One part of this meeting is to conduct some formal business as the section council rotates to a new set of officers. But the more intense and time consuming part of the meeting is where we discuss the opportunities for the section and our goals for the year. This year there was no shortage of subject matter as the effects of the financial crisis are still being felt across the industry, which if nothing else creates opportunity for articles, research and education. At the same time, I would like to echo the message of our outgoing Chairman that we have been ambitious in our efforts to bring new offerings to our members and I am confident in our direction.

While the crisis in many ways validated the actuarial approach to risk management, it is important that we work hand-in-hand with others inside and outside of our profession to make sure our voice is being heard. The Dodd-Frank financial reform bill will impact many of us, and we are looking to provide our expertise to those who influence public policy.

This is also a time of uncertainty in the investment world. As unprecedented measures are being taken to stimulate the economy, the range of economic outcomes has become harder to model and predict. This has proven to be a challenge that our methods and assumptions must respond to. We on the council look to respond as we put together the presentations for the year.

There are a number of things we are actively working on that I would like to highlight:

- The planning for the section's premier event, the Investment Symposium, is well under way. It will be held in New York, on April 11–12. Under the capable leadership of our returning chairman Bogdan Ianev, I anticipate a repeat of last year's topical and well attended event. The planning committee for this event has had several members of PRIMA on it, and we broadened the participation by adding members of the CAS, CFA Institute and Society of Quantitative Analysts.

- We recently co-sponsored, along with the Joint Risk Management Section, a follow-up to the successful collections of essays on the financial crisis that was published in 2009. The individual essays are being edited as this goes to print, and publication should be forthcoming.

Edwin Martin

- If you have not joined the Investment Section subgroup on Linkedin, I encourage you to take a few minutes to do so. This forum for section members continues to grow and has held some interesting discussions. (For those not familiar with it, membership in the group is controlled by our Section Specialist on the SOA staff, and limited to section members. What you see is from section members.)

- We have a number of volunteers working on webinars that should be available in 2011. We are excited by the potential of this medium to provide interesting content to our members in a convenient setting.

- We are looking for ways to increase the amount of research being produced. We are also working to connect more directly with the research community to help practicing actuaries have more of a dialogue with them. Given the upheaval in the economy and financial markets, we should be able to find plenty of interesting topics.

- Lastly, we sponsored an article competition that resulted in several articles that you see in this issue. The winner will be a few hundred dollars wealthier. (This is our kind of financial stimulus!)

I would like to say a few words of thanks to the volunteers who make it all possible. By the time you tally up all those who are involved in organizing the section activities and conferences, speakers and authors, and others the list is quite substantial. The section's success is a product of these efforts. If you feel you have something to contribute, whether it is the willingness to organize something or contributing as a speaker or author, let us know. Sharing your time, talent and enthusiasm helps us all.

We have a number of interesting and insightful articles in this edition of Risks and Rewards—enjoy!

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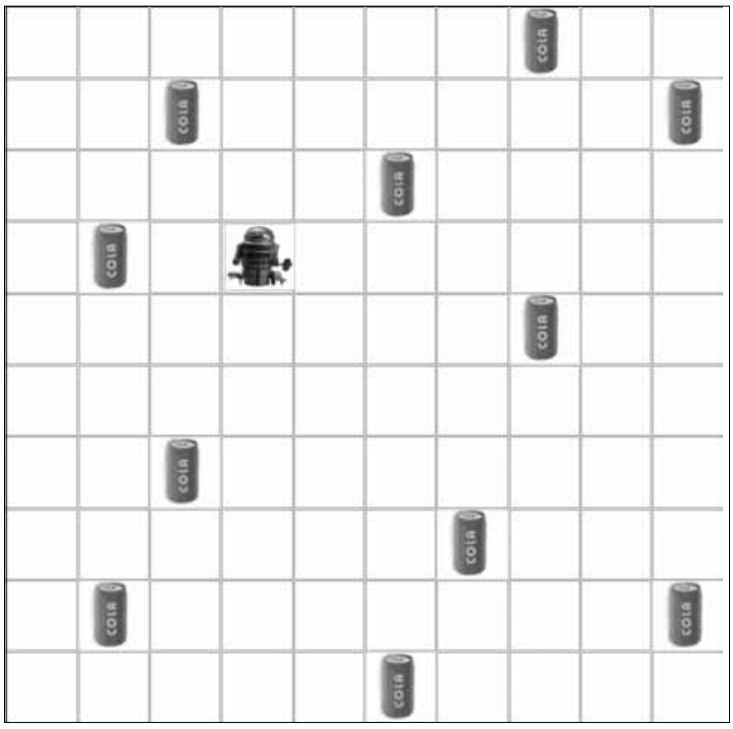
"IF THESE PEOPLE ARE SO SUCCESSFUL IN USING GENETIC ALGORITHMS, WHY CAN'T ACTUARIES?"

"ROBBY THE ROBOT"

Robby the Robot is a great example through which the steps of implementing a Genetic Algorithm can be learned. Robby lives in a 2-dimensional 10x10 matrix that is littered with empty soda cans. In this twist on Mitchell's example, Robby's job is to pick up the soda cans from the grid with increasing efficiency, while being blind and having no initial intelligence. Below is the process used to train Robby's brain through Genetic Algorithms:



1. Generate an initial population of solutions. This is done by creating random "individuals" from the universe of possible solutions. An important step here is the definition of individuals; in this case they are defined as different sequences of actions Robby can take. They are defined by a string of numbers that represent several actions {12315…} where 1=bend over to pick up can, 2=move North, 3=move East, etc.

2. Calculate the "fitness" of each individual in the current population. The fitness is defined by how well the solution performed, defined here by how efficient Robby's actions are. He receives +10 points for picking up a can, -1 point for bending over to pick up a can when there isn't a can there, and -5 points for running into a wall.

3. Select some number of individuals to become parents of the next generation. These parents are selected by using a "fitness function" that gives the individual a higher probability of being selected if it has a higher fitness as calculated in step 2.

4. Pair-up the selected parents through "recombining" parts of the parents to make offspring. The offspring then mutate with a given probability. Recombining can be done in many ways, but is done here by taking a portion of the string from parent #1 and a portion from parent #2, creating offspring #1, and using the unused portion of the parent strings to form offspring #2. Mutation is done by randomly changing portions of the strings. Inspired by nature, mutation maintains diversity in the population and prevents the population from converging too quickly.

5. Repeat steps 2–4 for a specified number of generations, or until a sufficient fitness is achieved.

The result of this algorithm is a solution that, in Mitchell's example, outperformed several solutions that were derived by computer scientists.

INTRODUCTION TO THE LIFE INSURANCE ALM PROBLEM

For our thought experiment, let's consider a life insurance company that measures its Economic Capital requirement for interest rate risk for an in-force block using the Principal Component Analysis (PCA) as described in "Options, Futures, and Other Derivatives."[7] PCA is an approach to measuring risk from groups of highly correlated variables, such as yield curve movements, into principal components that attempt to explain historical movements. Due to the orthogonal nature of the principal components, the principal components are uncorrelated, thus allowing us to measure our exposure to interest rates as:

$$f(x) = \sqrt{\sum_{n=1}^{k} (\text{Surplus Reduction from PC Shock n})^2}$$

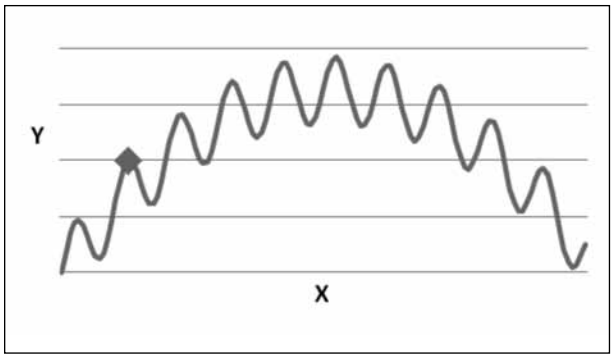
In short, the insurance company's goal is to reduce variability in surplus for given shocks to the interest rate curve.

Since this is an in-force block, the main tool that we have to minimize variability in surplus is our choice in asset allocation. Here lies the problem—we have thousands of assets to choose from to create our portfolio. Which ones and how much of each shall we choose? In practice, we would probably develop several portfolios and test them against the capital function and implement the best one. We may use other simple optimizers. The question we need to answer here is: can we do better?

ENVIRONMENTS WHERE GENETIC ALGORITHMS ARE USEFUL

There are several characteristics of problems for which Genetic Algorithms may be beneficial. Three of the characteristics and their applicability to our ALM problem are described below.

1. **The metric you are trying to optimize is not smooth or unimodal.** Many traditional search and optimization techniques will end up finding local minima. Consider the graph below:



[8]

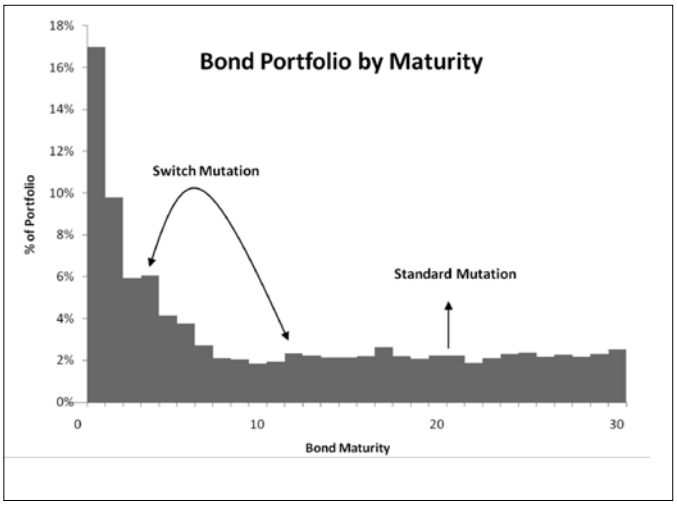
If we used an optimization technique such as Hill Climbing while trying to optimize the function given in the graph above, we may incorrectly identify a point as a global maximum. The basic principal of any variation of a Hill Climbing algorithm is to set an initial point, test the fitness to either side of the point, move to the point with the highest fitness, and repeat until fitness cannot be improved.

CONTINUED ON **PAGE 6**

> "ONCE THE BASE CODE IS TOGETHER (WHICH IS ACTUALLY QUITE EASY), THIS IS A POWERFUL TOOL THAT SHOULD BE PART OF EVERY ACTUARY'S TOOLBOX!"

In our ALM example, the fitness landscape is neither smooth nor well understood. A portion of this complexity comes from the way we measure fitness through the PCA approach and through the correlations of fixed income assets. If we were to compare two bonds with maturities one year apart, they would have similar market changes with a general move in rates, but a twist in the yield curve may cause them to act differently.

2. **The solution space is large.** If the number of solutions is finite and small, the best method is simply to try all of the options and choose the best one. Because we have thousands of assets to choose from and any dollar amount of each that can be purchased, there are infinite combinations of asset portfolios that we could try. The method that is often used is to narrow the universe of investable assets and limit the investment increments. However, there are still too many combinations to test, and if the universe is limited too far, we may have eliminated the best portfolio before beginning testing.



3. **It is a situation where good solutions tend to be made up of good building blocks.** If a portfolio of all short bonds does very well, the assumption is that short bonds are good building blocks of a great portfolio.

LIFE INSURANCE ALM APPLICATION

In applying the Genetic Algorithm technique to solve this life insurance ALM problem, I used a fair number of variations from the standard procedures found in texts. It is important to remember that Genetic Algorithms are a tool; they should be modified to fit your needs and to develop new uses. I used the basic steps of Genetic Algorithms as described above and modified them to fit with this example.

As noted above, the universe of assets is immense. I limited the scope of my model to concentrate on the optimum maturity profile to manage interest rate risk. The asset choices were limited to an investment grade corporate portfolio with 30 bonds—one for each maturity year up to 30 years. Instead of choosing a random initial generation, I used a population size of 600, with each initial individual being a portfolio with the entire portfolio invested in a single bond. Rather than defining the individuals as a string, I defined the individuals as a 30 element array, with each element being the dollar amount invested in each of the 30 bonds. The fitness in my example is easily defined by the capital function described above.

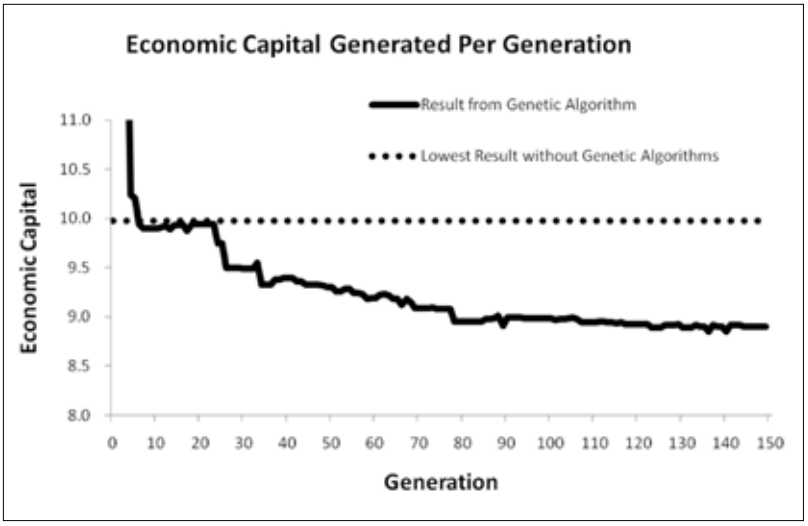
Once the parent individuals were chosen, I recombined the strategies by weighted multiples of the two parents' strategies chosen with random weights. The mutation was done in two ways—first, a random maturity bucket could be set to a random weight, and second, two maturity buckets could swap weights. This maturity bucket swapping was a great way to eliminate early convergence on local minima. After 150 generations, a suitable result was obtained. (See Illustration to the left)

The Genetic Algorithm solved for an investment strategy that reduced the capital by about 10 percent further than the other

two methods attempted—Hill Climbing and trying large numbers of reasonable portfolios. Even though Hill Climbing was more structured, it wasn't robust enough to capture the global minimum.

To the right is the graph of the best investment strategy from each of three generations of the model. The model tended to learn in bursts—the best strategy was similar from generation to generation for a few iterations, and then a new portfolio that had a much better fitness emerged. For example, from generation four to generation five, the model learned to get the asset duration correct. In later generations, the model learned that a barbelled strategy worked better than a more bulleted one.

As you can see from the graph of Economic Capital (where less required Economic Capital is better), around generation 5 the Genetic Algorithm does about as well as our other methods, and then around generation 25 and beyond the algorithm discovers much better matched portfolios!



CONCLUSION

Genetic Algorithms have been used fruitfully in many other professions, and Actuaries should be creative in finding ways to adapt this technique to make it a valuable tool for our profession. Not only did the Genetic Algorithm discover a better investment strategy, but it also gave me a structured way to solve for a result. We don't want to rely on luck to find a portfolio that does a good job of ALM matching. Many more uses for Genetic Algorithms are yet to be discovered. I recommend looking at examples in the resources listed in the footnotes and then programming some of the examples yourself. Once the base code is together (which is actually quite easy), this is a powerful tool that should be a part of every Actuary's toolbox!

END NOTES

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Ben Wadsley, FSA, MAAA has worked for AEGON USA in Cedar Rapids, IA for 7 years in a range of Investment, Economic Capital, and asset/liability management roles. He is currently a risk manager for the Employer Solutions and Pensions division. He is also the current Chairperson of the Forecasting and Futurism Section of the SOA. He can be reached at bwadsley@aegonusa.com.

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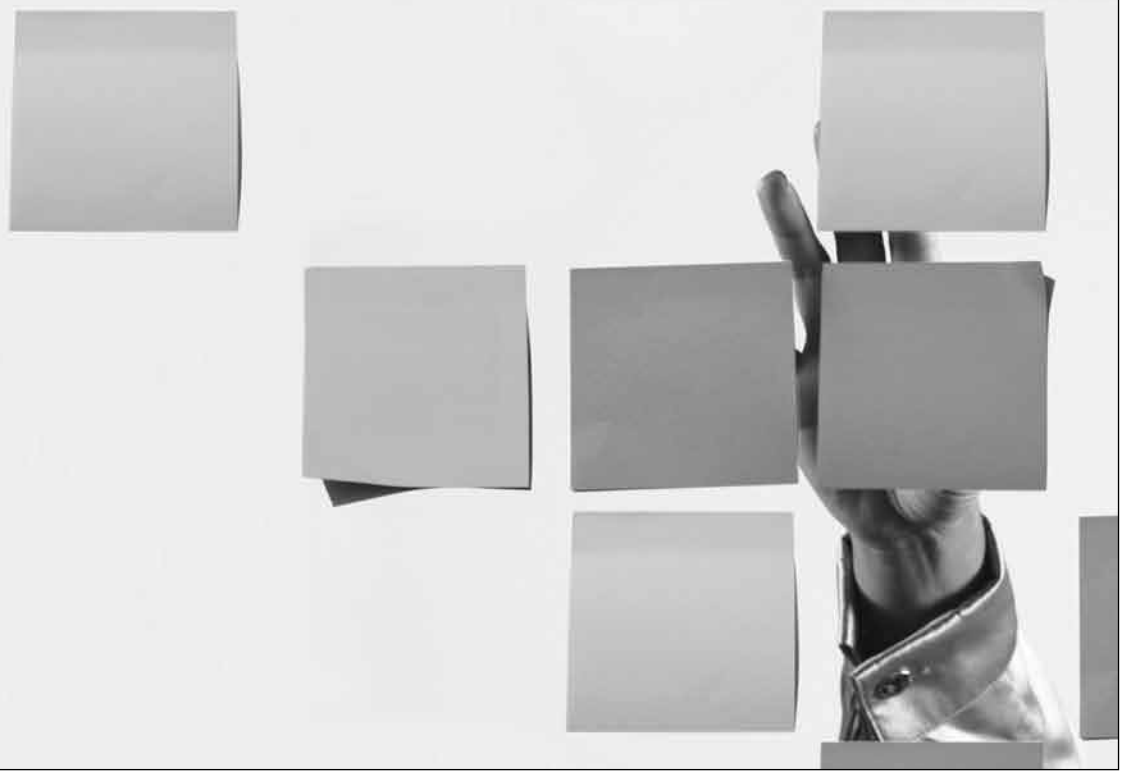

TAKING STOCK: WHAT IS THE REAL PROBLEM WITH ECONOMIC GROWTH

By Nino Boezio

One of the major items of discussion and concern over the past several years has been the matter of economic growth. Central banks have been adopting various means to stimulate their domestic economies so that business activity and consumer spending will resume in a sustainable and predictable fashion, and then continue to grow at a healthy rate.

Given that various governments have also engaged in fiscal measures to stimulate their economies, it has raised uncertainty as to what will remain in terms of economic strength once fiscal spending has ceased. There has been varying opinions as to how much the consumer will be able to do in order to pick up any shortfall, especially if governments also cut-back services in order to pay down burgeoning debt.

But one thing that I have found rather disturbing is the pervading trend of negative demographics impacting much of the developed world. This is not new information to actuaries, but sometimes we may forget its connection to economic growth. We have an aging population in much of the Western world with many people now entering a retirement phase. Those entering retirement will have different spending patterns. In addition, the declining birthrate over the past 50 years (in large part due to the widespread introduction of the birth control pill) has resulted in a relatively smaller generation of younger people following those who are retiring. If we have a younger yet relatively smaller generation of people who are expected to assume the burden of health care and retirement benefits for the aged, while also assuming the costs of past incurred government debt, will they have enough to spend to keep economic growth going?

We have all lived under the presumption (which on an overall basis has been valid up to now) that for the long-term economies will grow, companies will grow, countries will grow, and the world will grow. The common factor underlying all these beliefs is population growth, which naturally under normal conditions will produce an increase in consumer demand, even if all other factors remain static.

Now there is a strong reality that population decline will be something most countries will need to seriously contend with. In itself, it will produce negative demand which in turn will produce negative growth. We can only compensate by increasing productivity and hoping somehow that younger generations become wealthier faster and will spend significantly more than prior generations, in order to compensate for the decline.

NEGATIVE DEMOGRAPHICS

Even though the theme of negative demographics is not new to us, I was intrigued by some of the comments made at a presentation in 2009, since I never thought about them to this depth before.[1] The following is summarized from that presentation.

- **The demographics in the world today is disinflationary**— for the first time ever, most generations are not replacing themselves in the population pool, since most countries have birthrates that are low and are declining. The global population is aging at an extraordinary rate, especially in the developing world (and particularly in Asia).
- **When population growth reverses (shrinks), Gross Domestic Product (GDP) and consumption also decline** (offset in part by any potential increases from technology). Population growth leads to labor force growth that then leads to higher GDP but also higher consumption. We should note that a declining population is bullish for productivity since the labor force shrinks and therefore there is more reliance on technology.
- **Inflation is not sustainable under a global scenario of declining population** (even though we can have higher commodity prices) since it is hard to pass the higher prices to consumers. *The world is now in a race to 0 percent interest rates*. Japan has been winning this race, but it is not a race that any country wants to win.
- **Nominal or account dollar GDP drives interest rates (and both consist of a real rate and inflation component and are highly correlated together).** The issues related to demographics means that nominal returns on investments should also be lower for some time to come.

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> WE CAN ONLY COMPENSATE BY INCREASING PRODUCTIVITY AND HOPING SOMEHOW THAT YOUNGER GENERATIONS BECOME WEALTHIER FASTER AND WILL SPEND SIGNIFICANTLY MORE ...

THE UNITED STATES AND CANADA

- **America has an advantage because it is the only developed country with a replacement level birth rate** (2.1 vs. 1.6 for Canada—replacement birth rates are quoted on a 2-person basis). This is because marriage rates in the United States have been rising (and divorce rates falling).
- **Types of spenders**. In the United States the population is younger and therefore its people spend more than they earn (so it is not just explained by claims of careless spending). China is actually frugal primarily because of its older age demographics (not because it simply has a better attitude towards excessive spending). The United States and Canada are higher in consumption spending due to better demographics relative to other parts of the world.
- **Type of immigration**. Population growth in the United States is only 20 percent related to immigration, whereas in Canada it is two-thirds. The United States also succeeds because its immigration consists primarily of families (and therefore households already exist). Canada unfortunately is highly dependent on immigration in order to grow, for its birthrate is too low.

OTHER COUNTRIES

- **Many of the countries in the developed world are missing people aged 20-30, and this age group is what really drives consumption—**they leave home and then establish their own households which in turn generate spending. After that age range, the purchases are incrementally smaller. Also as people get older, they will have a flat or declining demand for goods (i.e., have less demand for "stuff") and instead will have rising demand for experiences, e.g., nice dinner, good game of golf, see a movie, etc.
- **Retirement saving**. The non-oil Sovereign Wealth Funds are all based in Asia. They represent the efforts of these countries to save for their own "retirement" (and once many of the people in these countries reach retirement, these countries will become importing economies). We cannot push China to spend, for it will run out of money by the time its people retire. Even though China has $2 trillion in reserves, this is not enough to support its population, for it would need at least $5–$10 trillion at this point in time for retirement purposes. We should note that Japan got rich before it got old and China will get old before it gets rich. The best 'retirement fund' for countries such as China is actually to have a strong family structure where kids support the parents (but unfortunately there are now few kids in China).
- **The BRIC countries (Brazil, Russia, India, China).** Brazil is the only country that is in relatively good shape. India has good demographics but does not have a sufficiently large educated workforce. Alternately, Russia has a shrinking population and a declining life expectancy due to alcoholism and suicide.
- **Japan**. Japan is in the worst financial shape (has chronic deflation) due to its negative demographics and this situation is not expected to reverse.

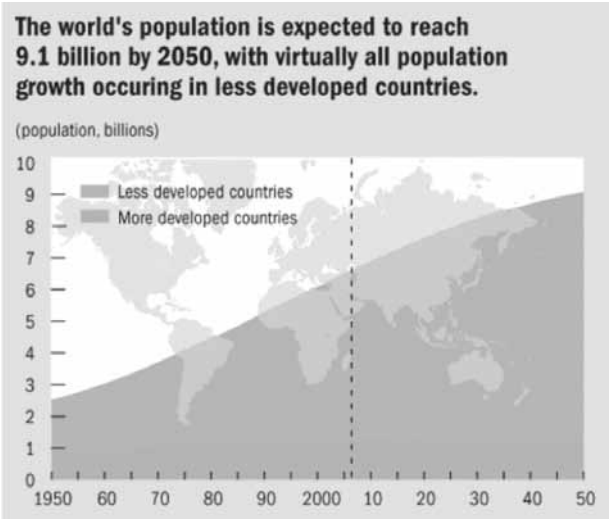
ADDRESSING THE DEMOGRAPHIC PROBLEM

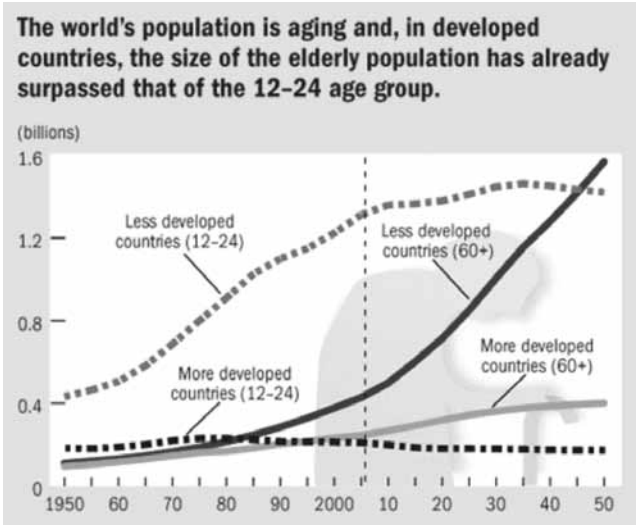
- **One of the greatest catalysts for change is women going to school, that also results in a lower birth rate**. When women achieve education they are less likely to get married, and even if they do get married they then tend to have fewer children. The birthrates in the Muslim world are the highest in the globe but are also falling, for women in this part of the world are also going to school.
- **Immigration**. With so many developed countries having below-replacement birth rates, immigration has become a much more important driver of country-specific population growth. However, Europe, as an example, used to rely on immigration but is now more restrictive because of concerns over religion (extremism).
- **Japan has become #1 in robots by necessity in order to replace its declining workforce.** Japan has needed more workers to serve in places such as nursing homes. But it has had to resort to technology to help cover its labor shortages.

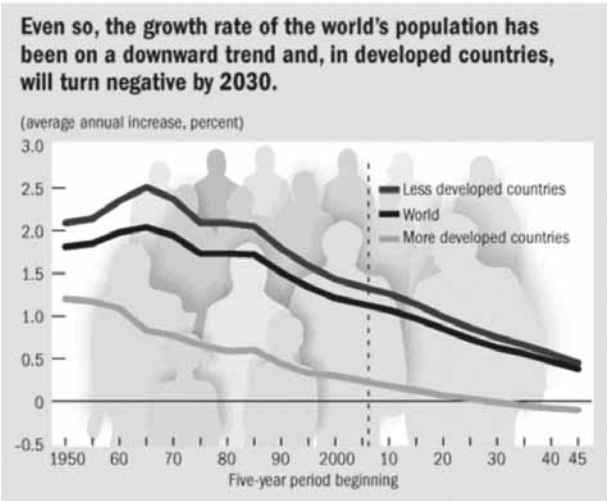
- **Basically, a country needs to fix its marriage rates.** This is the only effective approach to achieving a higher birth rate. Enhanced government maternity benefits, baby bonuses, improved paid leaves from work, and subsidies for domestic home help, are expensive and have had only a small overall impact.

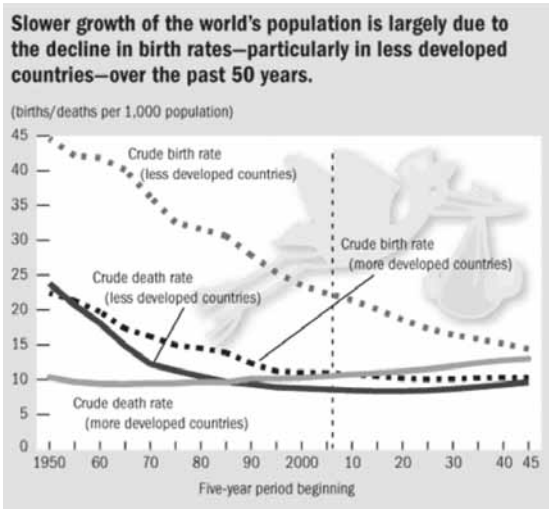
As I already mentioned, population growth naturally produces increasing demand. It also enables increasing productivity in absence of technological advances. Technology may solve at least part of the decline in productivity resulting from a declining workforce which ultimately follows from a declining population. But hoping and wanting a smaller working population to buy "more stuff" in order to satisfy the need for high consumer demand will be increasingly difficult, especially if working incomes are not also rising dramatically. Perhaps if there is a large wealth transfer (due to inheritance as the older generation passes, for the older generation may be wealthier than what we have seen in past history) then some of this may actually occur.

The four charts below published by the IMF give a more graphic perspective [2]:









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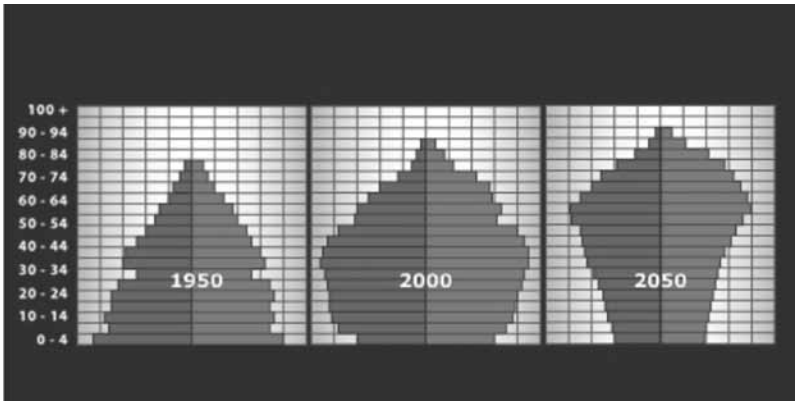

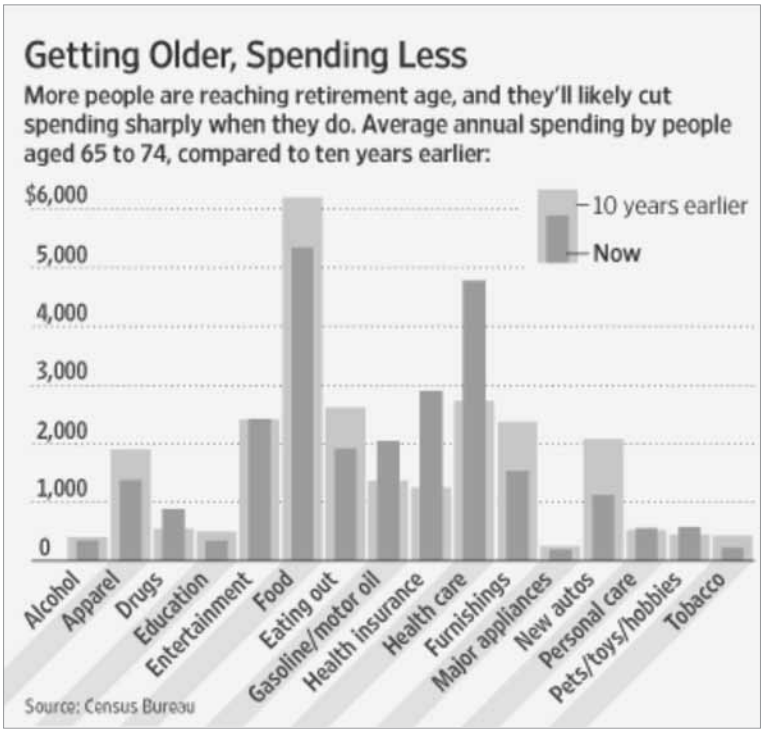

We will witness a major shift in the global age breakdowns over the next several generations, and this is not what has naturally occurred in history (of course subject to various diseases, war, and other calamities which sometimes has impacted one age group or gender disproportionately to another.)[3] (See chart, top, left)

Spending is certainly impacted as one becomes older. The expectation is that on a total spending basis, the average overall amount spent will be lower, especially after retirement. (See chart, bottom, left)

INVESTING

Negative demographics also mean we have to be more selective in what we invest in. Before, a chewing gum or toothpaste company could reasonably expect to sell more of its product with little product enhancement. The company could grow by almost standing still, since the population was growing. Now with the prospect of declining population, such a company will need to find ways to cut costs or produce its product more effectively and also to take market share, simply to stay in the same place in terms of revenue or profitability.

As we may have seen with certain companies and industries (e.g., manufacturing, auto industry, airlines), those that cut back on health and pension benefits for their employees, would often have the best prospect for earnings growth and expansion. These companies would be better able to attract shareholder and institutional investor interest. The same viewpoint could eventually be adopted regarding countries. Those countries providing less costly social programs for its workforce and that maintain a lesser tax burden could become more appealing.

CENTRAL BANK AND LENDING POLICY

Central banks have adopted the view for the past century, that lowering interest rates will increase the demand for credit and increase spending. Now such a policy may only keep demand at the same level. Also the absolute level of interest rates may need to be lower than in previous generations due to the

> CURRENT DEMOGRAPHICS HAVE NEGATIVE IMPLICATIONS FOR ECONOMIC GROWTH. WE MAY NOT FULLY UNDERSTAND ITS EXACT IMPLICATIONS, FOR IN RECENT MEMORY WE HAVE NOT EXPERIENCED IT ON SUCH A SCALE BEFORE.

declining population trend. Central banks have also used much of their interest rate firepower already, by taking their rates to very low levels (often near zero).

Inflation should be of lesser importance overall, even though it could be a factor for various commodities (e.g., oil) where the supply may be dwindling faster than any decline of demand. Perhaps the biggest risk to inflation is the fact that some countries have gotten so deep into debt (as has been the fear for some countries in Europe), that it appears that the younger generation cannot pay it, leading to future defaults, devaluation and thereby localized inflation. Some research has cited that it is not likely that all countries will be successful in unwinding their debt bubble.

Lending has been an important component for corporate expansion. As companies grew, they would borrow to expand facilities. This was an overall trend in the developed world. With a declining population, there likely will be fewer companies able to expand, and many will actually be shrinking or going out of business. Lending will still take place to modernize a facility or to expand in a certain region, but this may occur in fewer cases. So the overall demand for corporate borrowing will also decline. Unlike the past where we had upward pressure on interest rates due to borrowing demand, we may now see downward pressure on rates as demand wanes over time.

It is not often clear whether central banks truly understand demographics. Addressing changes in demographics does involve long-term thinking while monetary policy is more short-term. It therefore may not always be clear when monetary policy will stop working the old way. It will actually require modifications over time to address population shifts.

REAL ESTATE

Real estate investing will also be a challenge and one will need to be more selective. Some cities can still grow if population shifts to that area, while many can decline. It may also depend on whether more population shifts from rural to urban centers, in which case many cities may maintain their size while many rural areas including towns could virtually disappear. We will also find more residential housing entering the marketplace, as older residents pass-on or enter nursing homes.

THE FREE LUNCH THAT GOT EXPENSIVE

Positive or stable demographics did give us the prospect of a "free lunch." Social programs including those providing retirement benefits allowed governments the credit of giving their constituents benefits which did not truly cost the government anything, since the next generation was going to pay for them (the pay-as-you-go funding approach). This revolving door philosophy worked well when overall demographics were moving in the government's favor. Now with burgeoning government debt burdens and the realization that the next generation may not be able to afford it, there has been some push to rollback various benefit promises before the crisis could become very real. We have seen those moves in countries such as France and Greece, but those actions were met with strikes and protests. We will see more attempts in other countries to rollback benefits, since even though such moves are not popular, they will be increasingly necessary to balance budgets and to match with revenue from taxes.

Government debt becomes less of an issue when the overall population increases, as the per capita expenditure is less of a burden. Countries could grow themselves out of problems. With a declining population however, we need to see government debts reduced. Otherwise we have a generation that cannot afford to pay for its own benefits plus that of its parents', while also trying to survive on its day-to-day living costs.

SUMMARY

Current demographics have negative implications for economic growth. We may not fully understand its exact implications, for in recent memory we have not experienced it on such a scale before. We may get clues from looking at the experience in Japan, but the insights are not very encouraging.

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An increasing domestic and world population solved many problems in terms of being able to support social programs, spending programs and corporate expansion. Now the world may face economic declines in many areas partly caused by a declining population, at a time when government debt levels are high and when promises to older generations have become expensive.

The world has to unwind the excesses created in the past number of decades without causing major disruption. This will not be easy. It can also mean that profitability for companies, and the wealth for the country and individual consumer may not be as high as in the past. Investment will have to be more selective with a less optimistic view of financial performance.

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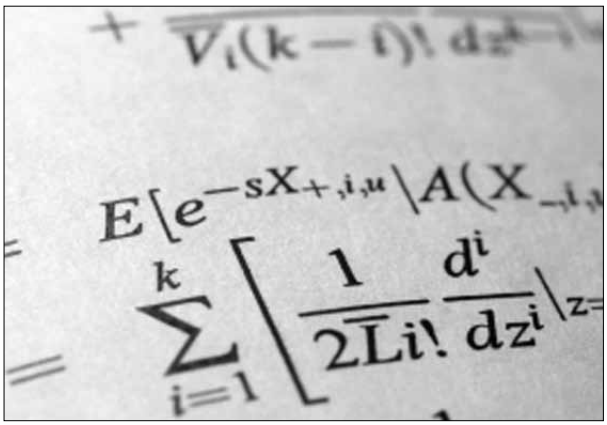

THOSE PESKY ARITHMETIC MEANS

By Dick Joss

It has been common in modern academic finance to assume that the arithmetic mean of a series of historical investment return results is the best estimate for next year's investment return on the particular type of investment. The best estimate for a multi-year forecast then becomes this arithmetic mean compounded for the forecasting period.

The rationale for using the arithmetic mean is quite straight forward. It is as if the actual historical results were written on little balls, the balls were placed in a giant rotating bin, and the year's investment return was obtained by drawing a ball out of the bin—just like a lottery drawing that might be seen on television. In this case the best estimate is, in fact, the arithmetic mean of the numbers on the balls in the bin. Sometimes this is referred to as a Monte Carlo simulation. All-in-all the approach seems fairly straight forward.

However, sometimes things that seem straight forward at first glance may turn out to be more complex. Determining arithmetic means is one of those times. For illustration data, consider the small company stock return data from *Ibbotson's Stocks Bonds Bills and Inflation 2008 Yearbook*. This data source provides historical investment returns for an 82-year period—Jan. 1, 1926 through Dec. 31, 2007.

If on Jan. 1, 1926, an investor had invested $1.00 in the small company stock portfolio described in the *SBBI Yearbook*, the investment would have grown to $15,091.10 by Dec. 31, 2007. The average annual increase in wealth over the 82-year period is 12.45 percent per year. However, instead of using this geometric mean return as a forecast, the academic finance community often cites the arithmetic mean of the 82 calendar years as the best estimate for next year's return. This number is a much higher 17.08 percent.

What goes unstated, however, is that the arithmetic mean of historical returns varies significantly based on the time period used for the calculation. If instead of using calendar years, Ibbotson had calculated the arithmetic mean using fiscal years ending in October the average return would have been 15.84 percent. If Ibbotson had used fiscal years ending in March, the arithmetic mean would have been 19.35 percent.

These differences could begin to impact investor behavior. Had investors been told that the arithmetic mean of small company stock returns was 15.84 percent instead of 17.08 percent, they might have been less inclined to invest in small company stocks. On the other hand, if the investors had been told that the historical arithmetic mean returns for small company stocks had averaged 19.35 percent instead of 17.08 percent, they might have been more inclined to invest in small company stocks.

Yet there is no particular reason for picking any one of the above arithmetic means over any of the others. The market itself does not rise up on each December 31, wave a big red flag, and shout: "Now is the 'right' time to measure stock market rates of return." The common practice of measuring these rates on a calendar year basis is just that—a common practice. As shown above, this common practice may be providing investors with information that might not be as full and complete as it could be.

Keep in mind one final time that every single one of the above numbers is based on the same set of data. In every case the original dollar invested on Jan. 1, 1926, is still worth $15,091.10 on Dec. 31, 2007. The only difference between any of the arithmetic mean numbers is the selection of the fiscal year used to group the data.

ANNUAL ARITHMETIC MEANS BASED ON SHORTER TIME FRAMES

The reason that the above different fiscal year calculations provided different arithmetic means is that for each of the calculations, a significant portion of the data is tossed away. For example, in each of the above Ibbotson small company stock return arithmetic mean calculations, only 82 different values of wealth growth were used (one for each fiscal year end), when 984 (one for each calendar year month) were available. Ninety-two percent of the available data was ignored!

In order to capture this extra data, it is possible to calculate an annual arithmetic mean rate of return in a very different way. Instead of ignoring 92 percent of the data, this process will use all 984 of the Ibbotson monthly wealth values. Using this process, one first takes the arithmetic mean or average of all the monthly returns provided in the *SBBI Yearbook.* This monthly average is then converted into (or expressed as) an annual equivalent rate of return. This process uses all of the listed Ibbotson data, not just a small fraction of it.

For the small company stock returns, the arithmetic mean of the monthly data is 1.3207 percent. This result is simply obtained by adding up all 984 monthly returns and dividing that total by 984. If an investment earns this rate of return each month for 12 months, the rate of return for the year will be 17.05 percent. This process is referred to as converting the monthly rate of 1.3207 percent into an annual equivalent rate of 17.05 percent. Using this process, one could say that the annual arithmetic mean rate of return for small company stocks was 17.05 percent. It is just that this annual arithmetic mean was based on monthly observations.

Some people may be uncomfortable referring to an "annual" arithmetic mean, when the data that was used to calculate it was monthly in nature. To help relieve some concern in this area, think about the answer to the question: How fast are you driving your car? If someone asks you this question while you are actually driving, your normal response is to look at your speedometer and report the speed as something like 45 miles per hour.

By reporting the speed as "45 miles per hour" you are not stating that you actually drove 45 miles, or that you actually spent one hour doing it. You were describing the speed at which you were driving at the time the question was asked using commonly understood terminology. In the same way, describing the monthly returns as 17.05 percent per year uses annual terminology to describe the arithmetic mean of monthly returns.

Because this new annual equivalent rate of return reflects observations from 984 data points (one for each month) instead of 82 data points (one for each year), there may be some comfort to the idea that this number is somehow more accurate because of the increased number of observations.

But anyone who watches a business news program on television is now keenly aware that data is available much more frequently than monthly. Often there is a little window on the television screen which shows the current Dow Jones Industrial Average (DJIA) value. This number changes every few seconds. If one calculated an annual Dow Jones Industrial Average arithmetic mean by just using month-end data, he or she would be throwing away millions of pieces of information as to how the DJIA changed over the course of a year.

This raises a question: Is it possible to calculate an arithmetic mean which captures as much of this data as possible? The surprising answer is yes! It is possible to calculate an arithmetic mean which reflects absolutely every single change in an investment such as the Ibbotson data or the DJIA, or even every single transaction involving an individual share of stock. This calculation process is described below.

"ARITHMETIC MEANS" FROM CONTINUOUS GROWTH

Given that using monthly data to calculate an annual rate of return still means that millions of pieces of information will be lost, the idea of using even smaller time increments, such as a week, a day, or even an hour, might be considered as a possible time period for figuring an arithmetic mean that could then be converted into an annual equivalent rate of anticipated investment growth. The concept of calculating arithmetic means by using more data points and then converting the results to annual equivalents has a good feel about it. Somehow using more and more data gives one the feeling that the result may be more accurate than if just a limited number of observations of the wealth-growth are used.

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It turns out that figuring out the arithmetic mean of returns taken over a very small time frames is not as difficult as one might think. The first step is to consider how the value of a stock is determined and how this value changes over time. These values and changes are determined by actual investors, just like you.

For example, assume that Allen in Altoona decides to enter into a transaction to buy a particular stock at $20 per share at exactly 1:00:00 on Oct. 1, 2008. This action by Allen then sets the value of the stock at $20, until eight seconds later when Bob in Boston agrees to a transaction at $20.50 per share. Thus, $20.50 becomes the new value. At exactly 1:00:24 Cheryl in Chicago makes the next transaction for shares at a price of $20.25. This process continues on and on and on. The stock market in action is truly a marvel to behold.

The first two transactions were eight seconds apart and the next two were 16 seconds apart. This illustrates a significant problem if one tried to calculate an arithmetic mean rate of return based on changes in share value calculated over one second time intervals. What would be the share value for times like 1:00:01, 1:00:02, and 1:00:03 when no transactions occurred?

The answer to this is really quite simple. Just estimate the share price assuming that there is a smooth line that connects every single one of the actual transactions! The smooth line just fills in the gaps between any two actual transactions. Using this new line, a person can estimate a value for the stock for any point in time, even times when no transaction occurred. This process just provides for a reasonable transition from one transaction to the next. This line is what is known as a "continuous and differentiable" curve, and it is easy to show that one can always be created in these types of situations.

While it is not common in modern finance to consider such curves when thinking about or calculating average returns, the concept is really quite logical. The curve passes through the data point for every single transaction of the stock! Not one single transaction is missed. The smooth curve is used only to fill in the gaps between any two successive transactions. And the gaps are always filled with reasonable stock values, which are in between the two actual transactions at each end of the gap. Assuming that stock price changes may be described by a continuous and differentiable curve, it is now possible to calculate an annual arithmetic mean that reflects absolutely every transaction for the stock. This new annual arithmetic mean is just the annual equivalent of an arithmetic mean of historical results taken over very, very small time frames. Using all of the data, instead of just a minor portion of it, seems to provide additional assurance that one is getting the "right" answer.

The current method of calculating an annual arithmetic mean as shown in the *SBBI Yearbook* uses just 82 data items from the historical record. That's all, just 82 separate pieces of data. If the process is expanded to monthly, then 984 pieces of information contribute to the calculation process. If the annual arithmetic mean is determined by taking daily snapshots of what was happening, then the calculation would have over 20,000 data elements. But even with daily numbers, the calculations would still miss all the market changes that occur within a single day.

If the calculations were carried out by taking the arithmetic mean of the rates of return over 1/10 of one second time intervals, the total volume of information would be over five billion individual observations of market behavior! It just seems natural that this result would have to be a far more accurate measure of the annual arithmetic mean than the relatively crude 82 element calculation process that is currently used.

There is an amazing answer that results from calculating the arithmetic mean or average of these five billion rates of return calculated over 1/10 of one second time intervals and then expressing this arithmetic mean as an annual rate of return. This amazing answer is that this process yields the geometric mean!

In other words, if the arithmetic mean calculation process used absolutely every single transaction, and then only filled in the gaps between transactions with a reasonable curve with

> MAYBE IT IS TIME TO REPLACE ALL OF THOSE PESKY ARITHMETIC MEANS WITH A SIMPLE GEOMETRIC ONE.

values between the two actual transaction values, the annual equivalent of the resulting arithmetic mean is the geometric mean. Using only a limited number of data snapshots from the historical record produces an array of arithmetic means, all of which are larger than the geometric mean.

INVESTOR IMPACT

The above information now expands the possible range for arithmetic means for Ibbotson small company stock returns. This new range of possible arithmetic means runs from the geometric mean of 12.45 percent, which is based on billions of data point observations, to 19.35 percent, which is based on 82 observations taken as of each March 30. The value of $10,000 invested for 20 years at these two rates ranges from $104,518 to $343,913. Dramatic differences in possible investment forecasts are beginning to show up.

It has been well-documented that workers who had planned on retiring with significant balances in their savings plans have been very disappointed. The cover article of the Oct. 19, 2009, issue of *TIME Magazine* was devoted to the hardships being faced by workers caught in this problem. To the extent these workers are relying on overly optimistic projections based on traditionally-calculated arithmetic means, perhaps it is time to seriously consider more conservative investment forecasting concepts.

CONCLUSION

The important point to be taken from this article is that any particular history of investment fund performance has lots of arithmetic means, and as shown above, these means can differ significantly. Any time you see a reference to "the" arithmetic mean of a data set, watch out! The asserted result is heavily dependent on which of the various arithmetic means was used. In particular, while the calendar year arithmetic mean of the 82-year historical small company Ibbotson stock return data is, in fact, 17.08 percent, using an alternative, yet still equally valid approach to calculating an arithmetic mean, this result could have varied anywhere from a low of 12.45 percent to a high of 19.35 percent. And it is particularly significant that the arithmetic mean based on the most data is the 12.45 percent number. Maybe it is time to replace all those pesky arithmetic means with a simple geometric one.

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REVISITING ASSET-ALLOCATION STRATEGIES FOR DEFINED CONTRIBUTION RETIREMENT PLANS: A LOOK AT AVAILABLE RISK-MANAGEMENT STRATEGIES

By Andrew Fisher and Wade Matterson

In the wake of the recent financial crisis, fund trustees, plan sponsors, and administrators are reconsidering traditional asset-allocation strategies. With increasing numbers of people approaching retirement age, the need to manage financial risks through more effective strategies is clear and urgent. Fortunately, there are a number of promising approaches available to help funds select, implement and administer the appropriate strategies.

The recent financial crisis has prompted many questions about the security of retirement funds. With the importance of the retirement sector growing as larger numbers of people approach the end of their working lives, defined contribution (DC) retirement plans in particular are coming under increasing scrutiny because of their vulnerability to sustained market downturns.

The steep market downturn between late 2007 and early 2009 exposed many flaws in traditional asset-allocation principles and risk-management techniques. Consequently, many DC plan administrators are reassessing their approaches, paying special attention to structures and strategies that are designed to manage risk more effectively. This article highlights a number of popular strategies, identifies issues for consideration, and offers a view of the potential implications and evolution of DC systems around the world.

The recent market downturn clearly demonstrated that traditional investment approaches are vulnerable to extended periods of market volatility. This is particularly worrisome to members of DC retirement plans because their investment assets are exposed to market risk. Globally, there has been a substantial shift toward DC plans during the past quarter-century. This development, combined with demographic changes that now see increasing numbers of workers approaching and entering retirement, suggests that it is time to improve upon the risk-management techniques and options currently in place.

The financial crisis not only reinforced the vagaries of market forces but also shook many people's confidence in the institutions that traditionally provided guarantees or insurance against such events. The high-profile corporate failures of institutions such as Lehman Brothers and American International Group (AIG) brought counterparty risk to the forefront. Pension plans that would have looked to institutions such as these as partners who could deliver risk-management solutions to their members paused to reconsider other methods of providing investor security.

As a result, we are now seeing rapid change as funds move toward more sustainable processes and structures for managing their members' investment risks. Much of the focus for these changes is upon independent administration or internal solutions that reduce or eliminate reliance on, and the resulting exposure to, third-party financial institutions.

OVERVIEW OF POTENTIAL STRATEGIES

There are three basic approaches to mitigating risk: diversification, hedging, and insurance. Any of these approaches may be justified depending on the individual investor's circumstances and stage of life.[1]

As risk becomes more relevant to fund members as they enter retirement, new approaches to investment are being assessed. Broadly speaking, they fall into one of three categories:

- administration strategies,
- derivative strategies, or
- insurance/outsourcing.

ADMINISTRATION STRATEGIES

Administration strategies rely on dynamically altering the underlying investment mix to achieve a smoother return or risk-management outcome. Three approaches that appear to be growing in popularity are target-date funds, target-volatility funds, and continuous portfolio protection insurance (CPPI).

Target-date funds: This strategy rebalances investors' assets between different mixes of conservative and growth assets

based on an age-based "glide path," traditionally focused on the investor's planned retirement age. The principle behind target-date funds (also known as life-cycle funds, target-maturity funds, and age-based retirement funds) is that investors need to adopt more conservative investment styles as they approach retirement. Target-date funds, however, have become the subject of much criticism. Debate has centered on the grounds that there is no "one-formula-fits-all" solution to the requirements of investors with widely varying needs, lifestyles, and levels of risk tolerance,[2] and also that, absent risk-management techniques, market volatility can defeat even the most carefully planned glide path.

Target-volatility funds: Like target-date funds, target-volatility or controlled-risk funds attempt to manage investor risk through rebalancing, but instead of focusing on an investor's age, the rebalancing is based on market volatility. The funds are designed to increase allocations to conservative assets in times of high volatility, and growth assets in times of low volatility. Target-volatility funds are relatively new entrants into the market, and time will tell how well they perform.

Continuous portfolio protection insurance: CPPI has been around for some time in various forms. In general, CPPI rebalances investors' assets between bonds and growth assets based on an algorithm designed to replicate an option. The goal is to preserve capital, and CPPI may be combined with options provided by an investment bank to offer a guaranteed solution.

CPPI, however, has suffered because of negative publicity focusing on investors getting locked into cash who were unable to participate when markets rebounded. The next generation of CPPI is on the way, but given the level of administrative complexity involved, it remains to be seen whether this technique will be popular.

DERIVATIVE STRATEGIES

Derivative strategies rely on the use of assets that directly facilitate risk management. Institutions have used derivatives to hedge risk for hundreds of years. Derivative strategies can work by creating exposure and by managing risk.

Creating exposure: Some strategies utilize derivatives to provide market exposure while combining them with conservative assets to provide security—for example, a bond combined with a call option.

In this example, fund members would allocate assets to a bond portfolio that is designed to provide a steady yield over the desired time period. Some of the yield would then be used to purchase call options that provide exposure to stock market returns. The degree of exposure would vary based on the option costs as well as the budget provided for their purchase.

Managing risk: Alternatively, derivatives may be used explicitly to hedge risk. The variety of instruments and methods available gives funds flexibility in structuring solutions that fit with their approach—for example, option budgets, put options, and futures.

In principle, each of these strategies should yield similar outcomes, but in practice they may produce different results depending on the legislative and tax environment within which the investment is structured.

INSURANCE/OUTSOURCING COUNTERPARTIES

There are a variety of outsourcing counterparties available depending on the nature of the risks a fund is looking to protect. Ultimately, institutions such as insurance companies or investment banks provide a "wrapper" for the provision of products utilizing various asset allocation strategies. For example, a fixed annuity provides access to fixed income assets whilst variable annuities provide access to equity, fixed income investments, and derivatives within an insurance context. The attractiveness of these structures is that the insurance company

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"THERE ARE THREE BASIC APPROACHES TO MITIGATING RISK: DIVERSIFICATION, HEDGING, AND INSURANCE. ANY OF THESE APPROACHES MAY BE JUSTIFIED DEPENDING ON THE INDIVIDUAL INVESTOR'S CIRCUMSTANCES AND STAGE OF LIFE."

is capable of providing investors with a guarantee supported by its balance sheet and capital.

When dealing with counterparties, it is important to ensure that the exposure is managed and that there is sufficient flexibility to alter a fund's arrangements over time without creating legacy issues.

This, together with portability, has been a major concern of fund trustees globally, and perhaps explains the relative lack of third-party insurance solutions within DC pension schemes. As discussed below, new approaches are being developed that may help overcome these issues.

KEY PRINCIPLES

Our experience suggests that, when evaluating competing strategies, there are a number of fundamental principles to consider. Ultimately, selecting the appropriate solution will depend on the circumstances of each particular fund, including demographic profiles and operational requirements, as well as distribution and advice capabilities.

The Value Proposition—What Risks?

Fundamental to each strategy is the need to address underlying member issues. As the focus has shifted from the management of returns to the management of risk, so too have approaches moved away from a pooled or "one size fits all" model to strategies that are customized at an individual level. This shift of approach reflects the need for flexibility and the increasing competition between different sectors of the retirement savings market, which results in a blurring of the line between occupational pensions and retail wealth-management models.

Types Of Risk

In terms of specific risks, market risk has dominated the recent debate, but there are a variety of issues that can affect the sustainability of an individual's retirement savings, including:

- **Longevity risk:** the risk that investors might outlive their assets,
- **Market risk:** the risk that negative investment returns diminish savings,
- **Inflation risk:** the risk that higher-than-anticipated inflation erodes savings faster than expected,
- **Health risk:** the risk of higher-than-expected health care expenses, and
- **Behavioral risk:** the risk of poor planning or investment decisions that can result in inadequate retirement assets.

It is possible to design effective risk-management strategies for any and all of these risks within a variety of products and strategies involving all issues collectively or separately (e.g., managing health risk through health-insurance strategies).

However, it is important to be aware that any risk-management solutions will need to function within the local regulatory environment without impinging on investors' tax or social-security status.

Cost

Whatever approach is adopted, cost will play an important part in both the ability to create an attractive proposition and the ultimate outcome to the investor. Any calculation of costs needs to take into account the following:

- **Market cost of protection:** What is the cost of manufacturing the risk protection required? There is no free lunch here with all solutions bounded by the prices that the capital markets put on risks.
- **Distribution costs:** What is required to inform and educate plan members about the benefits of risk-management strategies?
- **Administration costs:** Any solution is likely to require additional administrative effort and it is important to ensure this is conducted efficiently.
- **Profit for third parties:** Are there any third parties

involved and, if so, what are their profit requirements? For example, in the event that a guarantee is offered, the institution offering the solution will be required to hold capital and will need an adequate incentive (return) to do so.

- **Opportunity cost:** Even in cases that don't require a third party, the solution is likely to involve an opportunity cost commonly experienced through sacrificing market growth or upside in order to fund downside protection.
- **Transparency:** Given the potentially complicated structures underpinning some of these solutions, transparency to fund administrators and members will be vital.

COUNTERPARTY RISK

The long-term nature of retirement, combined with the fiduciary responsibilities of fund trustees, complicates the development of many traditional insurance-based solutions. Problems involving a third party can damage a fund's reputation—not to mention the financial interests of its members. Recent examples across the insurance and banking industries have prompted fund administrators who work with third parties to exercise high levels of scrutiny and monitoring.

Other ways of managing counterparty risk include:

- **Short-term commitments:** adopting approaches that rely on shorter commitments or instruments, or that eventually eliminate or reduce reliance on third parties;
- **Collateralization:** ensuring that third-party obligations are funded—something that is critical to protecting the fund and maintaining the ability to migrate from one provider to the next should a significant event make it necessary;
- **Risk pooling:** spreading risk across multiple counterparties; and
- **Internal or independent administration of solutions.**

Finally, those wishing to adopt solutions will also need to consider the administrative burden of the various solutions and assess whether they have sufficient expertise to administer them over very long time periods.

OTHER CONSIDERATIONS

In addition to developing the risk-management strategy, pension schemes will need to factor in communications to members and trustees, as well as their organizations' operations and expertise.

Funds have a responsibility to communicate with their membership bases whatever strategy they put in place, and will need to invest time and effort in educating members on the risks they face and the risk-mitigation benefits offered by the strategy.

As far as operations and expertise are concerned, many of the available risk-management strategies require sophisticated administrative solutions and a level of expertise that an organization's staff might not have. It is therefore important to take advantage of outside experts who can support the development and administrative effort involved in effective risk management.

PUTTING IT ALL TOGETHER

A number of potential models for developing risk-management strategies appear to be evolving:

- **Outsourcing:** This option is mostly limited to small funds that wish to retain an administrative role but do not have the necessary in-house staff resources and are comfortable outsourcing to a third-party institution. Selecting the correct partner and carefully monitoring performance will be critical.
- **Partnership:** Some funds may elect to work with a third party that assists by independently administering collateralized or pooled structures in order to ensure that the fund's fiduciary duties are met, as well as to provide independent advice as appropriate.
- **Internal operations:** Some large funds will elect to develop their own risk-management solutions, with the option of outsourcing certain operations to others who have the appropriate expertise.

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In summary, there is a wide range of alternative structures available to assist in the management of risk. These ultimately need to be considered in the context of the fund and its members.

Strategy	Description	Comment
Target Date	Allocations between growth and conservative assets is determined based on age	Consistent with existing approaches, but can be ineffective through periods of sustained volatility
Target Volatility	Allocations between growth and conservative assets is determined based on volatility	Theoretically attractive approach that is beginning to gain traction in the market
CPPI	Rebalances assets between bonds and growth assets based on an algorithm designed to replicate an option	Low perceived cost, but administratively complex and potential for "cash lock"
Bond + Call	Bonds provide security and market upside is provided through option exposure	No long-term counterparty exposure
Option Budget	A budget is established for the purchase of options to provide protection	Relatively simple to administer, but budgets can be ineffective in times of high market volatility
Dynamic Replication	Futures are rebalanced to replicate any option-based strategy	No counterparty exposure and low cost, but can be exposed to market gaps if operations are not robust
Insurance	Utilises a third-party insurer to provide an integrated product solution	Can include longevity risk (lifetime income guarantees) and other guarantees, but introduces long-term counterparty exposure

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ORPHANED VEBAS – AN APPROACH TO MAXIMIZE VALUE AND DISTRIBUTE WEALTH

By Chad Hueffmeier and Zhao Lang

Over the past few years, several companies have been able to spin-off Voluntary Employee Beneficiary Associations[1] (VEBAs) and the associated retiree medical liabilities for a negotiated amount.[2] These arrangements create "orphaned VEBAs" in which the investment risk is transferred to participants. This fact combined with the tax advantages associated with retiree medical benefits allows us to clearly define a framework that maximizes value for participants in aggregate while providing the flexibility to allocate wealth among individual participants in various ways.

Individuals should make investments decisions within the context of their total portfolios. Thus, investments held within an orphaned VEBA should impact how participants allocate their other wealth (e.g., investing in bonds in the VEBA allows participants to hold less in bonds outside of the VEBA). This combined with the fact retiree medical benefits are the most tax efficient form of deferred compensation[3] should lead participants to want orphaned VEBAs to hold highly-taxed assets (e.g., fixed income, hedge funds) to help maximize their wealth on an after-tax basis.

Furthermore, plan design and investment risk dictate how wealth is allocated among participants of orphaned VEBAs. As the percentage of annual cost paid by the orphaned VEBA decreases and (or) investment risk increases, wealth is shifted to younger participants.

SIMPLE MODEL

Participants bear the investment risk from an orphaned VEBA making it effectively an aggregated savings account. Thus, participants should view the orphaned VEBA assets similarly to assets in any tax-advantaged savings plan and make investment decisions within the context of their overall portfolio. For simplicity, we will assume there is only one participant receiving benefits to illustrate two key points: (1) investment risk taken in the VEBA should be reflected in participants' personal portfolios, and (2) highly-taxed assets should be held in an orphaned VEBA.

We will assume the participant's target portfolio is 50 percent fixed income and 50 percent equity. In Figure 1, we have illustrated two potential allocations of VEBA assets—100 percent equities versus 100 percent fixed income—and the corresponding allocation of personal savings required to achieve the target allocation. This simply demonstrates how investment risks taken in an orphaned VEBA impacts participants' ability to take investment risks within their personal savings. If less investment risk is taken in an orphaned VEBA, it allows participants to take more risk with their personal savings while maintaining a target level of risk.

Retiree medical benefits offer distinct tax advantages. Unlike defined benefit and 401(k) defined contribution income that is taxed upon distribution, retiree medical payments are tax-free so "retiree medical savings" is more tax-efficient than other

FIGURE 1

Participants' Holdings	Orphaned VEBA: 100% Equity	Orphaned VEBA: 100% Fixed Income
Indirect holdings: through orphaned VEBA		
Equity	$1,000	$0
Fixed Income	0	1,000
Total	$1,000	$1,000
Direct holdings		
Equity	$4,000	$5,000
Fixed Income	5,000	4,000
Total	$9,000	$9,000
Participants' combined holdings		
Equity	$5,000	$5,000
Fixed Income	5,000	5,000
Total portfolio	$10,000	$10,000

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savings. This is important because not all assets are taxed in the same manner – long term capital gains (e.g., stock and real estate appreciation, qualified dividends) are taxed at a lower rate than ordinary income (e.g., interest payment on treasury and corporate bonds, nonqualified dividends). Consequently, participants should prefer highly-taxed assets to be held in an orphaned VEBA. Figure 2 illustrates how having highly taxed assets (e.g., fixed income) in an orphaned VEBA improves tax-efficiency. As shown in the example, shifting the assets of the orphaned VEBA to all highly taxed assets resulted in an increase in the participant's after-tax income from $590 to $595.

COMPLICATING ISSUES

Orphaned VEBAs have numerous participants and do not contain individual accounts; this complicates how value is distributed among the participants. Value distribution is governed by decisions regarding two key issues: (1) annual cost sharing, and (2) investment risk.

FIGURE 2

Orphaned VEBA: 100% Equity	**Participant Holdings**		**Return**		**Investment Income**		**1 - Tax Rate**	**After-tax Income**
Orphaned VEBA								
Equity	$1,000	×	10%	=	$100	×	(100% - 0%)	$100
Fixed Income	0	×	5%	=	0	×	(100% - 0%)	$0
Total	$1,000				$100			$100
Direct holdings								
Equity	$4,000	×	10%	=	$400	×	(100% - 15%)	$340
Fixed Income	5,000	×	5%	=	250	×	(100% - 40%)	150
Total	$9,000				$650			$490
Total portfolio	$10,000				$750			$590

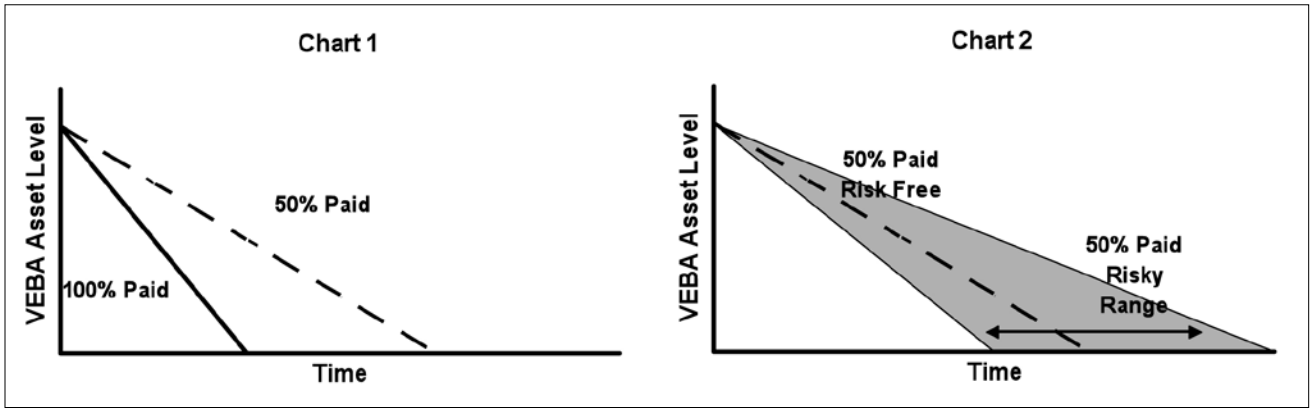
Orphaned VEBA: 100% Fixed Income	**Participant Holdings**		**Return**		**Investment Income**		**1 - Tax Rate**	**After-tax Income**
Orphaned VEBA								
Equity	$0	×	10%	=	$0	×	(100% - 0%)	$0
Fixed Income	1,000	×	5%	=	50	×	(100% - 0%)	$50
Total	$1,000				$50			$50
Direct holdings								
Equity	$5,000	×	10%	=	$500	×	(100% - 15%)	$425
Fixed Income	4,000	×	5%	=	200	×	(100% - 40%)	120
Total	$9,000				$700			$545
Total portfolio	$10,000				$750			$595

> "...EXAMINATION OF DISTRIBUTION IN THE VEBA IS SIMPLEST, AND IN OUR OPINION, BEST ACCOMPLISHED ON A RISK-FREE BASIS, ELIMINATING ANY EXTRANEOUS REALLOCATION OF WEALTH DUE TO INVESTMENT RISK."

Cost sharing could vary by participant based on numerous factors (e.g., years of service). For simplicity, we will assume the same cost sharing percentage is used for all participants. Chart 1 illustrates how assets would be depleted over time if VEBA assets were used to pay 100% versus 50% of retiree medical costs. Given younger participants would be expected to receive benefits longer than older participants; increasing cost sharing (i.e., lowering the percentage of cost paid by the VEBA) would be expected to lower value distributed to older participants and increase value distributed to younger participants.

Investment risk not only impacts how participants' should allocate assets in their savings plans but also can impact how value is distributed among participants. Chart 2 illustrates the projected depletion of assets when 50% of retiree medical costs are paid by the trust under two scenarios: (1) risk-free investment strategy (straight line for illustrative purposes), and (2) a risky investment strategy (range of potential asset drawdowns depending on asset performance). In the first case, the orphaned VEBA would be expected to be depleted of assets before some younger participants would be expected to commence benefits. These younger participants would then require investment risk to even have a chance of having retiree medical coverage. Thus, increasing investment risk shifts wealth to younger participants (Chart 2).

Distributing value in a VEBA is a complicated process involving various factors such as participant contributions, future benefit changes, Medicare coverage, etc., not to mention any number of special provisions a VEBA may have in place to protect subgroups of participants. Therefore, examination of distribution in the VEBA is simplest, and in our opinion, best accomplished on a risk-free basis (or at least a low risk basis), eliminating any extraneous reallocation of wealth due to investment risk. Furthermore, "defined dollar retiree medical



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benefits" would provide an addition level of precision (relative to benefits dependent on contingent factors) when allocating value from an orphaned VEBA.

CONCLUSIONS

The investment strategy developed for orphaned VEBAs needs to reflect that investment risk is borne by participants and also to reflect the tax-efficiency of retiree medical benefits. These facts should lead those responsible for investment strategy to limit the allocation to highly-taxed assets.

Given orphaned VEBAs do not contain individual accounts; the value distributed to each participant is driven by cost sharing and investment decisions. As the percentage of annual cost paid by the orphaned VEBA decreases and/or investment risk increases, wealth is shifted to younger participants. We believe the examination of distribution in the VEBA is simplest, and in our opinion, best accomplished on a risk-free basis (or at least a low risk basis), eliminating any extraneous reallocation of wealth due to investment risk.

Treasuries and most non-municipal fixed income investments are taxed at ordinary income rates, so they satisfy both the highly-taxed consideration and can be used to structure a low risk portfolio allowing for a straightforward distribution of wealth among participants.

END NOTES

1. A VEBA is a form of tax-exempt welfare plan, first established in 1928 in response to demands from workers' association. Under Internal Revenue Code section 501(c)(9) a VEBA is "organized to pay life, sick, accident, and similar benefits to members or their dependents, or designated beneficiaries if no part of the net earnings of the association inures to the benefit of any private shareholder or individual." Throughout the 1970s and early 1980s, VEBAs were abused by the wealthy as a tool for tax deduction. In 1984, VEBA use became limited due to the Deficit Reduction Act, but to this day, VEBAs remain as powerful tax shelters when used to provide employee benefits.
2. This sometimes includes predefined or contingent future contributions which could be considered "receivables".
3. Participants are never taxed on these benefits.

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"RISK-FREE" LIABILITIES

EFFICIENT PENSION MANAGEMENT REQUIRES THE RIGHT BENCHMARK

By Chad Hueffmeier and Shirley Cheung

Traditional pension asset allocations contain so much risk that the details of the "liability benchmark" have been largely ignored. In the new pension paradigm, private plan sponsors (sponsors) are considering immediate reductions in risk and/or developing dynamic de-risking strategies that reduce risk as their plan becomes better funded. In either case, sponsors need to build their strategies around a "risk management liability" benchmark because it drives both risk allocation and de-risking decisions.

Neither accounting nor funding liabilities should be used to manage risk. Although these measures have migrated toward "mark-to-market" liabilities, the rules are still somewhat arbitrary and do not facilitate efficient risk management. In fact, the methodologies used to develop hypothetical spot curves, the survivor bias, the credit spread duration, and the smoothing mechanisms embedded in these measures are impossible to hedge.

Furthermore, a risk management liability should not arbitrarily contain credit spread risk. As sponsors "de-risk" their plans, the inclusion of credit spreads in the benchmark would essentially deem credit as "riskless" and would artificially bias sponsors toward taking only one type of risk—credit risk.[1] In fact, sponsors should use a risk management liability benchmark based on accumulated benefits that are measured with "risk-free" rates. This would avoid the unnecessary bias towards credit risk and allow sponsors to continue taking advantage of diversification as pensions are de-risked.

PENSION RISKS

There is a clear distinction between the two primary types of risk within defined benefit pension plans—*demographic* risks, which are inherent in liabilities, and *investment* risk, which is driven by the sponsor's financing strategy. These risks are ultimately addressed in two distinct ways:

- Demographic risks[2]—Sponsors can pay a premium to a counterparty to transfer the risk. Note that arbitrary regulations and/or negotiations (e.g., lump sum rules) can sometimes lead to artificially low prices, which could be considered negative risk premiums.
- Investment risks—Sponsors can invest in a manner that *guarantees* a given asset will be available to pay a given benefit payment. For purposes of managing investment risks, the benefit payments are presumed to be certain.

CAPITAL REQUIRED TO "DEFEASE" PENSION RISKS

Sponsors may fully "defease" the financial risk of pensions by either transferring pension liabilities to a third party in exchange for a premium (e.g., group life annuities); or retaining pension liabilities, paying a third party to transfer demographic risks (hence, "locking in" required benefit payments), and hedging benefit payments with pension assets. While transferring liabilities currently requires the lesser capital[3] of these two options, relatively few sponsors may have the opportunity to transfer liabilities because we estimate the annual U.S. annuity capacity to be less than 2 percent of outstanding U.S. corporate pension liabilities.[4] Consequently, the majority of sponsors will likely retain their liabilities and manage investment risk more deliberately.

In addition, demographic risks tend to be recognized over decades, not within the time horizon in which management is typically concerned about risk. Consequently, a third strategy many sponsors might consider is to retain pension liabilities and hedge *expected* benefit payments. (If sponsors target the capital required to hedge expected benefit payments, they could still monitor their ability to use the liability transfer option as their funded status improves.) For the rest of this discussion, we can ignore demographic risk and treat expected benefit payments as certain.

PENSION PROTECTION ACT (PPA) LIABILITIES DO NOT FACILITATE CASH FLOW MANAGEMENT

In the past, U.S. contribution requirements for qualified plans provided sponsors with relatively stable contributions compared to the amount of risk that was being taken in plans. Contributions were still quite volatile, but not nearly as volatile as mark-to-market gains/losses. Funding regulations accom-

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plished this by masking risk with smoothing mechanisms (e.g., asset smoothing, amortization of gains and losses and plan amendments over periods ranging from five to 30 years, etc.).

In the new pension paradigm, economic risk related to pensions is relatively transparent due to the migration toward marking-to-market assets and liabilities. This leads sponsors to make more conscious decisions about risk, which often results in taking less risk. When that happens, the smoothing mechanism in funding regulations can be counterproductive and actually increase cash flow volatility. Hence, U.S. funding regulations have evolved to give sponsors the ability to use or not to use some limited smoothing. However, the regulations still make it impossible to fully manage the plan's cash flow risk.

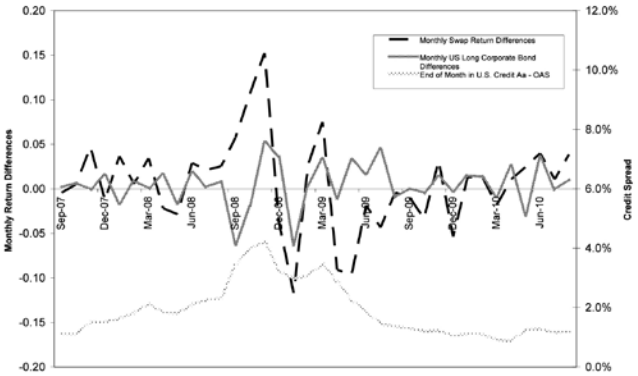
The Pension Protection Act (PPA) of 2006 lets sponsors use "spot rates" to measure pension liabilities. In theory, measuring pension liabilities using spot rates should enhance sponsors' ability to manage cash flow risk and economic risk. However, the methodology used to develop the "PPA curve" blends Aaa-, Aa- and A-rated corporate bond yields averaged over the previous month. This means PPA liabilities, and hence contribution requirements, cannot be fully hedged for the following reasons:

- **Hypothetical spot curve:** The PPA curve is a product of methodology and does not reflect an investible portfolio.[5]
- **Survivor bias:** The PPA curve only contains "survivors." As bonds are downgraded, they are simply no longer incorporated when developing the PPA curve. An actual asset portfolio would experience losses from defaults and downgrades.
- **Credit spread duration:** There simply are not enough long maturity corporate bonds available for sponsors to get long maturity credit exposure.
- **Smoothing:** By definition, "market smoothing" does not reflect market values, so the averaging methodology used over the previous month cannot be hedged.

The graph below illustrates how monthly returns of "duration matched" asset portfolios deviated from the monthly returns on a PPA liability[6] from September 2007, the first month for which the IRS published the PPA spot curve, through August 2010. We have illustrated two hypothetical asset portfolios:

1. Swap Portfolio, a portfolio of cash plus fixed-for-floating swaps with notional exposures aligned with projected benefit payments, and
2. Long Corporate Bond Portfolio, a portfolio perfectly replicating the Barclay's U.S. Long Corporate Bond Index. Note that the Barclays U.S. Long Corporate Index tracked closer to our PPA liability than other long duration fixed income benchmarks over this period.

Using the PPA Liability as a Benchmark



A perfect hedge for the PPA liability on this graph would show a 0 percent deviation. Any deviations above and below the horizontal axis indicates the portfolio would have "tracking error"[7] relative to the PPA liability. The tracking error of the Swap Portfolio and the Long Corporate Bond Portfolio was 18- and 9-percent, respectively, over this period.

In addition, the graph shows the option-adjusted Aa spread over the same period. This illustrates the inverse relationship

> "...THE INCLUSION OF CREDIT SPREADS IN THE BENCHMARK WOULD ESSENTIALLY DEEM CREDIT AS 'RISKLESS' AND WOULD ARTIFICIALLY BIAS SPONSORS TOWARD TAKING ONE TYPE OF RISK—CREDIT RISK."

between changes in credit spreads and portfolio performance relative to the PPA liability. Although both asset portfolios are "duration matched," they have less "credit spread duration" than the PPA liability. Consequently, when credit spreads widen, these asset portfolios tended to outperform liabilities and vice versa.

ACCOUNTING LIABILITIES—BETTER BUT STILL UNHEDGEABLE

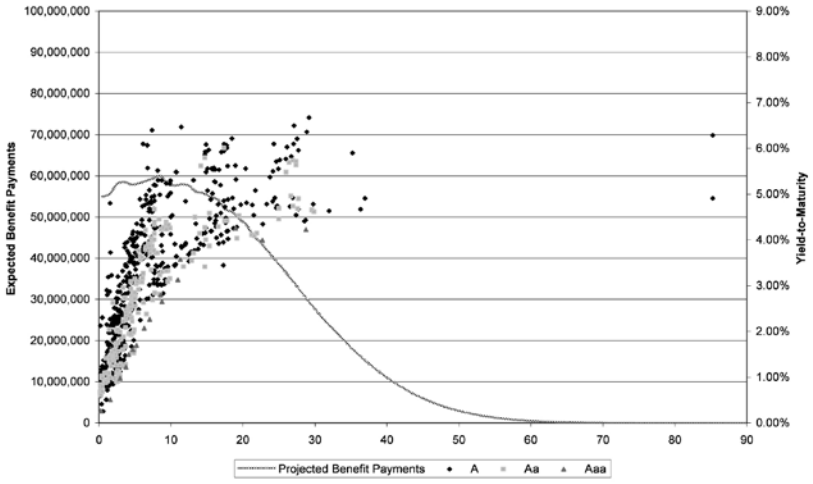
Absence of smoothing: Accounting standards measure pension liabilities on a basis that is more representative of the current economic environment than PPA, because the standard does not require smoothing over the previous month. Pension assets used for balance sheet purposes are reported at market value, and liabilities are measured using rates derived from the prevailing high quality corporate bonds.[8]

The key difference in the rates used to measure accounting liabilities from PPA rates is the absence of smoothing and the methodology used to estimate the spot curves.[9] In order to provide a direct comparison of how well the Swap Portfolio and the Long Corporate Bond Portfolio track accounting liabilities (measured with the Citigroup Pension Liability curve) versus PPA liabilities, the summary below reflects only the period from September 2007 through August 2010. While these portfolios better track accounting liabilities, a considerable amount of tracking error still exists.

	Portfolio Tracking Error (Sept '07 – Aug '10)	
Benchmark	Swap	Long Corporate Bond
PPA Liability	18%	9%
Accounting Liability	15%	5%

Inability to hedge "credit spread duration": A significant portion of the residual tracking error is driven by the "credit spread duration" mismatch. The graph below illustrates the number of high-quality U.S. corporate bonds that existed as of Aug. 31, 2010. The vast majority of corporate pensions would need bonds of at least 20 years to maturity to hedge liabilities. At the time, there were only 57 bonds issued with a total par value of $49 billion that had a maturity greater than 20 years.[10] This amount pales in comparison with the estimated pension liabilities for the S&P 500 of $1.6 trillion as of Aug. 31, 2010.[11]

High Quality U.S. Corporate Bonds



Source: Bloomberg as of Aug. 31, 2010

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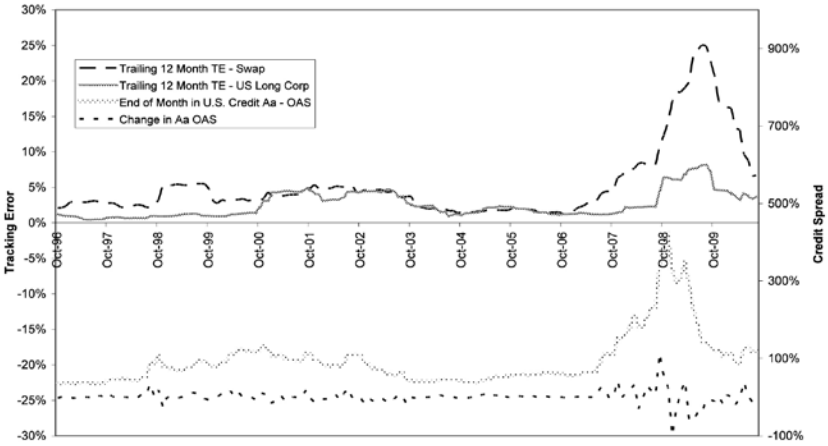
> "THERE IS OFTEN A MISPERCEPTION THAT THE PROJECTED BENEFIT PAYMENTS COULD BE HEDGED WITH A PORTFOLIO OF HIGH-QUALITY CORPORATE BONDS WITH A MARKET VALUE EQUAL TO ACCOUNTING LIABILITIES."

When fixed income managers construct long-duration portfolios, they are largely limited to long-duration treasuries/agencies and/or interest rate derivatives that contain inadequate credit spread exposure to hedge accounting liabilities. Hence, there is a credit spread duration mismatch.[12] The graph below illustrates the relationship between Aa credit spreads[13] and the tracking error of the Swap Portfolio and the Long Corporate Bond Portfolio relative to accounting liabilities from October 1996 through August 2010.[14]

Using the Accounting Liability as a Benchmark



When credit spreads are "tight," changes in credit spreads are relatively small, so both portfolios track accounting liabilities fairly well. This indicates the majority of liability volatility is driven by risk-free rates when credit spreads are tight. Even during moderate credit spread environments (e.g., January 1999 through September 2003), both portfolios hedge the majority of liability volatility.

On the other hand, when credit spreads are wide (e.g., July 2007 through December 2009), they can vary significantly. Hence, a significant amount of liability volatility is driven by credit spreads and the Swap Portfolio no longer tracks liabilities well.

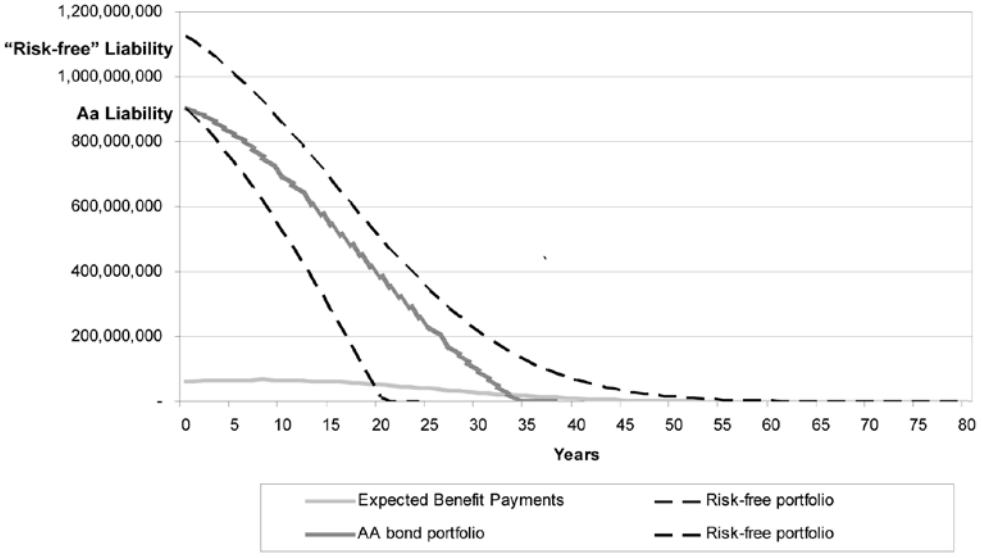
Although the Long Corporate Bond Portfolio does track accounting liabilities better when credit spreads are wide, the higher tracking error associated with the Swap portfolio could be considered "good tracking error." If credit spreads were hedged with the Long Corporate Bond Portfolio prior to credit spreads widening, the asset portfolio and liabilities would both decrease. On the other hand, if credit spreads were not hedged, only the liabilities would have decreased as a result of credit spreads widening so the tracking error in the Swap Portfolio would have been beneficial.

Survivor bias: The PPA curve and accounting curves are developed independently from one period to the next. As a result, they don't reflect losses that would have been created by bonds that were downgraded over the period. There is often a misperception that the projected benefit payments could be hedged with a portfolio of high-quality corporate bonds with a market value equal to accounting liabilities. However, this portfolio would be insufficient to pay for the projected benefit payments, because the portfolio would inevitably have defaults and/or downgrades (i.e., technical defaults).

In order to illustrate this concept, we have modeled portfolios invested in Aa bonds and in risk-free bonds in connection with our sample pension liabilities, on both a deterministic basis (using assumptions for defaults on Aa bonds published by Moody's[15]) and a stochastic basis using the GEMS® Economic Scenario Generator.[16] The first graph is based on the deterministic forecast. In this example, the liability for this stream of payments measured on a Aa basis is approximately $900 million. If a $900 million portfolio could be cash-flow matched with Aa bonds, the portfolio would be expected to run out of money in 35 years (assuming no future contributions).

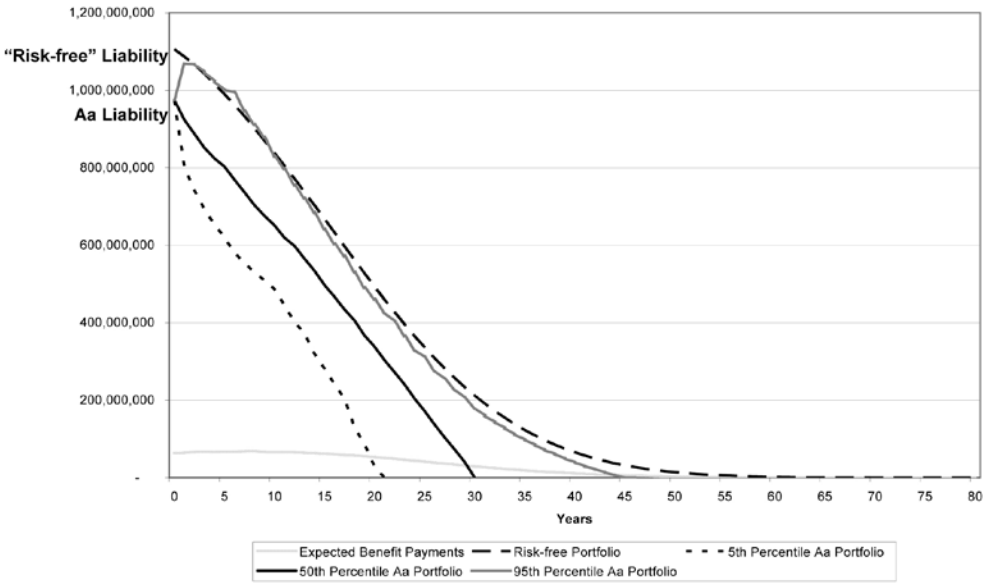
On the other hand, if the $900 million portfolio were invested in a "Risk-Free" Portfolio, it would be projected to run out of money in 20 years (bottom dotted line). In order for a Risk-Free Portfolio to pay all benefit payments, additional capital of approximately $200 million (totaling to $1.1 billion) would be required to offset the lower expected returns (top dotted line). (See chart, top, left).

The stochastic projection shown on the graph below provides similar results. In this projection, a $900 million portfolio would be expected to run out of money in 32 years. In the worst 5 percent of scenarios, the portfolio is projected to run out of money in under 20 years. In the best 5 percent of scenarios, the portfolio is projected to be sufficient for at least 45 years. But there are no scenarios where the portfolio is able to pay for all projected benefit payments. (See chart, bottom, left).



PROPOSED RISK MANAGEMENT LIABILITY

Accumulated Benefits Organizations need to manage compensation holistically so they provide competitive total compensation packages to employees. It is important not to manage components in isolation because independent decisions tend to allocate resources inefficiently. For example, the impact on pension benefits has not typically been considered when awarding salary increases. These uninformed decisions can cause sponsors unintentionally to provide a disproportionate amount of capital to longer service employees. Sponsors have control of pay increases and should make informed decisions.



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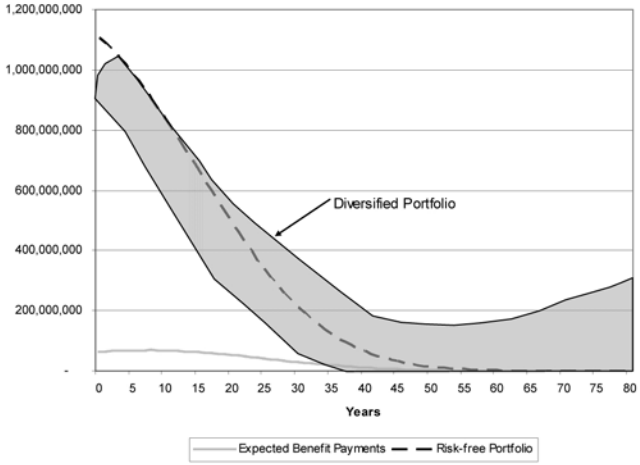
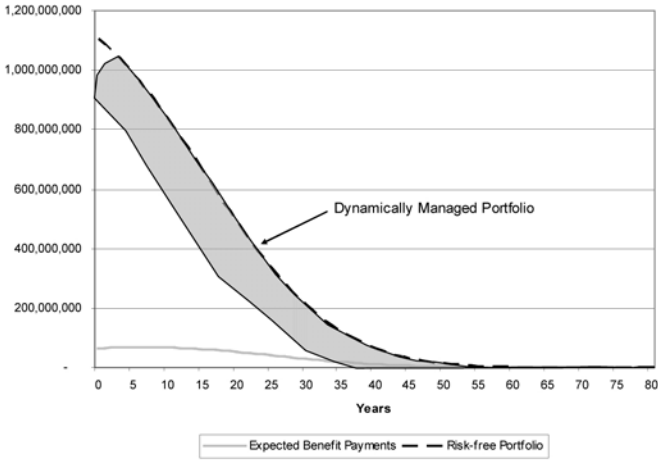
Furthermore, investment managers should not be held responsible for factors controlled by the sponsor. Including future salary increases in the risk management liability benchmark mistakenly classifies those increases as an uncontrolled risk, which often leads to the artificial bias towards real assets (i.e., assets providing some protection against the inflation component of salary increases). Because of this bias, the risk management liability benchmark should be limited to accumulated benefits.

Risk-free Interest Rates There is risk associated with offering credit to borrowers (or buying non-treasury bonds). The fact that funding regulations and accounting standards encourage sponsors to take credit risk over other types of investment risk is completely arbitrary. Sponsors must recognize the risk associated with providing credit (or owning non-treasury bonds), both to improve understanding of the amount of capital required to defease liabilities, and to force a conscious decision to be made about taking credit risk relative to taking other risks. Consequently, it is important for risk management liabilities to *exclude* credit spreads.

In general, there are two primary types of spot curves that could be used to develop a risk management liability benchmark: (a) a treasury curve, and (b) an interest rate swap curve. In either case, excluding credit spreads from the measurement of liabilities will avoid biasing the investment process. A description of portfolio construction belongs in a different article; however, the chart on the left side below illustrates how a diversified portfolio of risk would be expected to significantly outperform a portfolio limited to high-quality corporate credit (as illustrated in the previous section) which would never exceed the dashed risk-free line. Furthermore, understanding the capital required to actually defease liabilities allows the sponsor to properly develop de-risking strategies (e.g., hedging projected benefit payments with treasuries, transferring assets and liabilities to a life insurer).





> "... A DIVERSIFIED PORTFOLIO OF RISK WOULD BE EXPECTED TO SIGNIFICANTLY OUTPERFORM A PORTFOLIO LIMITED TO HIGH-QUALITY CORPORATE CREDIT ..."

Inflation protected benefits Although few U.S. corporate pensions provide inflation indexation, many public pensions and corporate pensions outside of the U.S. provide protection against inflation. The risk management liability benchmark for these plans should measured with real rates implicit in sovereign inflation-protected securities (where possible) or other types of inflation-protected products.

Cash balance plans Funding regulations and accounting standards can be seen as severely flawed with regard to valuing cash balance liabilities. The minimum liability should be at least the sum of the account balances. Although the economic liability is often significantly higher[17], the sum of the balances provides a reasonable risk management liability benchmark because a return based on this benchmark would equal the interest crediting rate. Note this approach should only be applied to participants with account balances.

CONCLUSIONS

As sponsors begin to reduce risk in their plans, it is important that they build their strategies around a "risk management liability" benchmark, since it influences both risk allocation and de-risking decisions. Ideally, this benchmark would be able to concurrently manage cash flow, accounting, and economic risk. However, the methodology used to develop spot curves, smoothing mechanisms, credit spread duration, and survivor bias makes this an impossible task.

No one would ever suggest sponsors should stop taking advantage of arbitrary accounting standards and funding regulations which understate pension liabilities. However, managing risk relative to a "risk-free" benchmark would improve sponsors' investment decisions; it would not arbitrarily bias sponsors to take credit risk, and it would provide the best estimate of the capital required to defease pensions.

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In absolute terms, domestic sovereign debt is the lowest-risk investment vehicle, so a purist would prefer a treasury curve. A liability measured with treasury rates could be hedged with a portfolio of treasury strips.[18]

In general, interest rate swap curves contain rates higher than treasury curves. That is, there is a positive swap spread.[19] However, unlike the credit spreads embedded in the curves used for accounting and funding, swap spreads do not tend to be driven by credit because collateral can be rigorously managed to minimize any counterparty risk related to swaps. The swap spread is driven by supply-and-demand for less capital-intensive vehicles, liquidity, and the fact the floating rate (e.g., LIBOR) exceeds treasury rates.

If a sponsor had capital equal to the liability measured with swap rates (i.e., the swap liability) and a portfolio of fixed-for-floating interest rate swaps with notional exposures aligned with projected benefit payments, returns on the underlying assets must be at least equal to the floating rate (which would be exchanged for the fixed rate on a net basis) to assure assets are sufficient to pay for liabilities over time. Given the floating rates are based off of LIBOR and these rates exceed treasury rates[20]; investment risk must be taken to try to achieve a return sufficient to service the float without prematurely depleting capital in this situation. Sponsors should understand the residual risk inherent in such a portfolio.

However, there are at least two potential advantages of using a risk management liability based off of a swap curve[21] : (1) it tends to provide a better estimate of the capital required to defease liabilities with an insurance company, and (2) it provides a benchmark that could be hedged with "interest rate overlay" portfolios. The latter is a practical consideration for plan sponsors that want to retain a substantial amount of capital for non-liability hedging assets. Ultimately, if the sponsor chooses to retain the liabilities and wants to minimize investment risk (i.e., restrict assets to liability hedging assets), the sponsor may want to migrate to a treasury measure of liabilities for the reasons indicated in the previous paragraph.

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END NOTES

[1] Technically, including credit spreads in the measurement of liabilities should only bias risk decisions toward credit spread risk, not default risk. However, in practice, there are limited ways to achieve this exposure so most portfolios containing credit spread risk also contain default risk.

[2] For simplicity, we will consider certain "hybrid" risks such as anti-selection that is potentially tied to the economic environment as a demographic risk.

[3] In our opinion, this is only possible due to inefficiencies in insurance business models, resulting in underpriced annuities (i.e., shareholder value is destroyed when group annuity business is written).

[4] Our estimate is based off of an informal survey conducted with several of the largest U.S. life insurers.

[5] Per IRS Notice 2007-81 that provides guidance on the corporate bond yield curve and segment rates required to compute the funding target under IRC Section 430, the yield curve is "calculated for each business day of the month based on investment grade corporate bonds in the top three quality levels. … The daily yield curve is expressed as the yield for a zero coupon bond at each maturity point from one-half year to 100 years, in half-year intervals. The value at any maturity point of the monthly yield curve is set equal to the arithmetic average for all of the business days in a month of the values for that maturity point from the daily yield curves. The monthly yield curve then is the set of values for each of the 200 maturity points."

[6] Based on a generic set of projected benefit payments with duration approximately equal to 12.

[7] Tracking error measures how closely a portfolio performs relative to a benchmark and is calculated as the standard deviation of the difference in returns between the portfolio and benchmark.

[8] The guidance on discount rates in FAS 158 paragraphs B86 and B87 references paragraph 186 of FAS 106, which states, "The objective of selecting assumed discount rates is to measure the single amount that, if invested at the measurement date in a portfolio of high-quality debt instruments, would provide the necessary future cash flows to pay the accumulated benefits when due. Notionally, that single amount, the accumulated postretirement benefit obligation, would equal the current market value of a portfolio of high-quality zero coupon bonds whose maturity dates and amounts would be the same as the timing and amount of the expected future benefit payments."

[9] Accounting liabilities also include the impact of projected future pay increases. Given we are essentially treating projected benefit payments as certain, we will only address the future pay increases issue with our final risk management liability benchmark recommendation.

[10] Data on corporate bonds with a Moody's rating of A1 or higher were downloaded from the Bloomberg system as of Aug. 31, 2010. The data was then screened to eliminate bonds that are inappropriate for determining discount rates under ASC 715. Because corporate bonds are not traded on exchanges, information on some bonds can be thin or doubtful. Accordingly, we exclude from consideration bonds with insufficient liquidity, bonds with questionable pricing information, and bonds that are not representative of the overall bond market.

[11] Pension liabilities, service cost and benefit payments for the S&P 500 companies were downloaded from Factset and rolled forward to Aug. 31, 2010 assuming an average duration of 12 and reflecting the change in the discount rate based on the Citigroup Pension Liability Index.

[12] It is possible to leverage exposure to credit spreads using credit default swaps (CDS) or other credit derivatives. However, these instruments tend to have short maturities (most commonly five and 10 years), so they do not offer exposure to the correct portions of the "credit spread term structure." In addition, it would require amounts of leverage most sponsors have not been comfortable taking.

[13] Option adjusted credit spread on U.S. Aa information was provided by Barclays Capital through August 31, 2010.

[14] The tracking error was calculated based on a trailing 12-month difference in returns between the portfolios and the accounting liability determined using the Citigroup Pension Liability curve. Note that monthly Citigroup Pension Liability curves were only available back to Sept. 30, 1995.

[15] An annualized recovery-adjusted default rate of -0.2% was estimated from the 20-year default rate on Aa bonds of 7% as published by Moody's in the January 1997 article "Historical Default Rates of Corporate Bond Issuers, 1920 – 1996" and an assumed recovery rate of 40%.

[16] GEMS® is a registered trademark of DFA Capital Management Inc. GEMS® is a state-of-the-art Economic Scenario Generator developed by DFA Capital Management Inc.'s team of quantitative finance experts and its financial models are amongst the most technologically advanced in the industry. GEMS

enables users to simulate future states of the global economy and financial markets including the pricing of derivatives and alternative assets and is designed to do large-scale, distributed, scalable simulations. GEMS generates all the financial economic and macroeconomic variables necessary for risk management including multiple correlated common stock indices, equity derivatives, alternative investment classes, treasury bonds, corporate bonds, mortgage backed bonds and CMOs, municipal bonds, interest rate derivatives, real estate, actual and expected multiple inflation indices, nominal and real GDP growth rate, foreign exchange and the unemployment rate.

[17] Cash balance plans generally provide embedded options (e.g., minimum interest crediting rates) and/or guaranteed future subsidies (e.g., above market returns such as one-year treasury rates plus 1%) so the economic value of the liabilities is often greater than the sum of account balance.

[18] In the U.S., treasuries are only issued out to 30 years so benefit payments projected beyond 30 years could not be fully hedged with treasuries. Although this would not eliminate future investment risk, treasuries would provide the lowest risk investment option.

[19] Note there has been a negative swap spread for long maturities since late 2008. This provides further support that the spread is driven by the indicated factors rather than credit.

[20] Over the past five, ten, and twenty years the average spread between 90-day U.S. LIBOR and 90-day treasuries has been 0.70%, 0.48%, and 0.44%, respectively.

[21] More detail regarding the attractiveness of using swaps to measure pension liabilities is provided in the August 2002 edition of Morgan Stanley's "Global Pensions Quarterly" - "Discount Benchmarks For Defined Benefit Pension Plans" written by Michael Peskin and James Moore.

CAN CANADA PROVIDE ANSWERS TO AMERICA'S REAL ESTATE MALAISE?

Over Time, One Market Held Up, One Didn't

By Jonathan Glowacki, Ken Bjurstrom, and Eric Wunder

In recent years the residential mortgage market in the United States has become severely distressed. The downturn in the U.S. residential mortgage market spilled over into the global financial markets due to the explosion of mortgage securitization over the last decade ultimately leading to what is now known as the "Great Recession." Although there have been recent signs of a recovery, the economic malaise continues in the U.S. residential real estate market. Housing starts fell to an annual rate of 276,000 for August 2010, down from 310,000 a year earlier, according to the Department of Commerce. In addition, bank repossessions of houses topped 95,000 in August, up 25 percent from a year earlier, according to RealtyTrac, a research firm. These sour numbers continue to put downward pressure on future home price projections.

Canada, on the other hand, has maintained a relatively stable residential mortgage market during these difficult times. Canadian housing prices are rising, with average home prices hitting an all-time high in June 2010, up 14 percent over a 12-month period, according to a house price index developed by Teranet, a data firm and the National Bank of Canada. Canada's recession was also less severe. For Canada's two quarters of negative growth, its real annualized GDP fell 3.4 percent in the fourth quarter of 2008 and 5.4 percent in the first quarter of 2009, according to Statistics Canada, a government agency. (That compares with annualized declines of 6.2 percent and 5.7 percent for the same period in the United States). Why the stark difference in economic performance between the two neighboring countries? A brief comparison of the two countries' mortgage policies may provide the answer.

GOVERNMENT POLICY

One big difference between the two countries involves how each government shaped housing policy in the 20th century. The United States' current system had its origin in the National Housing Act of 1934, a law that was part of the New Deal legislation during the Great Depression. The law was passed in response to the collapse in the value of homes and a wave of subsequent foreclosures that swept the nation during the Great Depression. "Congress affirms the national goal that every American family be able to afford a decent home in a suitable environment," the law stated. The act created the Federal Housing Administration (FHA), whose goal was to provide an affordable home financing system to low income borrowers through governmental mortgage insurance. FHA Insurance requires a small down payment (just 3.5 percent of the purchase price) and removes borrower credit risk from the lender to the government. The National Housing Act added to what was already a favorable tax climate for investing in real estate: the mortgage interest deduction was introduced in 1913, allowing homeowners to itemize mortgage interest payments from their taxes. Real estate taxes were also made deductible. The collection of these efforts allowed the government to encourage affordable housing for *all* Americans while giving less consideration to the borrower's ability to afford the home.

Subsequently to the National Housing Act, the government created government-sponsored enterprises (GSEs) to improve liquidity in the secondary mortgage market. Fannie Mae was formed in 1938, with the goal to expand the secondary mortgage market by securitizing mortgages. Mortgage securitization allows banks to move loans off the balance sheet and frees up capital, so the banks can provide buyers with more financing for home purchases. In 1970, Fannie Mae was authorized to buy private mortgages (those not insured by the FHA or another governmental agency), thus increasing the amount of mortgages that could be issued to borrowers who did not meet the FHA's underwriting guidelines. Freddie Mac was also formed that year to compete with Fannie Mae.

Canada took a different approach to home ownership. It formed the Canadian Mortgage and Housing Corporation (CMHC) in 1954, which, as its national housing agency, focused on maintaining housing supply and making home buying a practical option for those that had the means and desire to own a home. The CMHC was charged with promoting the construction of new houses, repairing and modernizing the current housing stock, and furthering the living conditions of Canadians. Its focus was on housing supply in the private markets, making owning a home a reasonable option and helping to reduce

the chance of mortgage defaults. So, while the United States focused on financing, Canada has a hand in directly helping citizens buy and stay in homes. CMHC mortgage insurance also has stricter underwriting standards: buyers must put 5 percent down, the CMHC has higher loan-to-value requirements for refinance loans, and debt-to-income ratios must use the average major lender-posted five-year rate as opposed to a current "teaser rate." Finally, Canada eschewed tax incentives for home ownership.

DIFFERENT POLICIES, DIFFERENT OUTCOMES

The government policies helped shape how citizens in each country approached home buying. The United States used lower down payments and tax incentives to reinforce its policy of every American owning a home. Canada instead shunned incentives and emphasized higher down payments focusing on quality housing for Canadians with the means to purchase a home. Since Canadians tended to have more equity in their houses due to the higher down payments, they also had a lower probability of default. The difference in policies meant a divergence in risk on the table for the financial industry. Mid-decade, about 22 percent of outstanding mortgages in the United States had a loan-to-value ratio (LTV) of 80 percent or higher, and 7 percent ranged from 90 percent to 100 percent. That compared with 16 percent of mortgages in Canada having an LTV of 80 percent or above, with 1.5 percent in the 90 percent to 100 percent range. The more equity (and inversely, lower LTV) an individual has in their home, the lower the default probability. American society seems to encourage stretching one's money which led to lower down payments and consequently a greater percentage of loans with high LTV ratios. This in turn corresponds to higher probabilities of default and inflated home prices as the demand for higher-priced homes artificially increased.

SECURITIZATION AND UNDERWRITING

Another key difference between the United States and Canada is their approach to securitization and underwriting, which were closely linked to the collapse of the residential real estate market in America.

The United States expanded the use of mortgage securitization in the 1980s, offering investors a steady stream of income. Issuance of "mortgage-backed securities" (MBS) took off in the 1990s, growing in popularity each year, reaching nearly $2.7 trillion in 2003, up from $318 billion in 1995. By the mid-2000s, the banks, thrifts and mortgage finance companies faced unprecedented demand for the securities by investors. MBS issuance represented 54 percent of all originations in 2000. By 2007, the percent of mortgage financing from securitization jumped to 81 percent. Another significant change involved the amount of non-agency—or private—debt being securitized. Non-agency debt includes loans that don't conform to the standards of Fannie Mae and Freddie Mac, such as subprime, Alt-A, and jumbo loans. Non-agency securitized debt represented just 12 percent of all originations in 2000; by 2006, that number ballooned to 42 percent of all originations or equivalently $1.1 trillion of originations.

Many U.S. originators began to issue riskier loans because they were more profitable, and the originators found fewer buyers with high credit ratings, leaving them to either crimp lending or move downstream to lower credit scores. The riskier loans included subprime lending, which made up 21 percent of all RMBS issuance in 2005, up from 7 percent in 2003. Meanwhile, so-called Alt-A loans also grew rapidly over the same time period. These included interest-only loans, those with little or no documentation (no-doc), no-down payment loans, and teaser loans that would reset to a higher interest rate at a later date. Alt-A loans securitization grew to 17 percent by 2005, up from 2.7 percent two years earlier. Debt-to-income ratios used for adjustable-rate mortgages (ARMs) historically were measured at the current floating rate, rather than the highest possible rate over a longer period of time, such as five years. This allowed riskier borrowers to pass the litmus test.

CONTINUED ON **PAGE 40**

As loans moved off the originators' balance sheets, so did the risk: for the most part, investors assumed the liability. Rising demand for the private-label MBSs continued, and originators went with riskier borrowers to help satiate the appetite of the investment banks, which packaged the bonds. Investment banks earned lucrative fees and were often able to structure the securities in such a way that they could still obtain a high credit rating from the rating agencies regardless of the collateral backing the security. Often MBSs laden with subprime loans received the highest possible rating, allowing large institutions around the globe to invest in what were deemed to be some of the safest fixed-income securities.

Loose underwriting, helped by low interest rates, meant credit was cheap and readily available. Both subprime and Alt-A lending increased the demand for homes by making credit available to borrowers who previously were not able to obtain financing. Meanwhile, the increase in the supply of homes could not keep pace with the increase in demand. This disconnect between supply and demand contributed to the rapid increase in property values. Furthermore, the artificial spike in demand was encouraged by the belief that home prices in the United States would not decline since they have not done so since the Great Depression. However, a slowing economy in 2006 eventually lead to falling prices leaving deeply leveraged home borrowers high and dry, precipitating record defaults and a wave of failures of financial institutions and mortgage originators.

WITH COOLER TEMPERATURES, A COOLER RECEPTION TO RISK

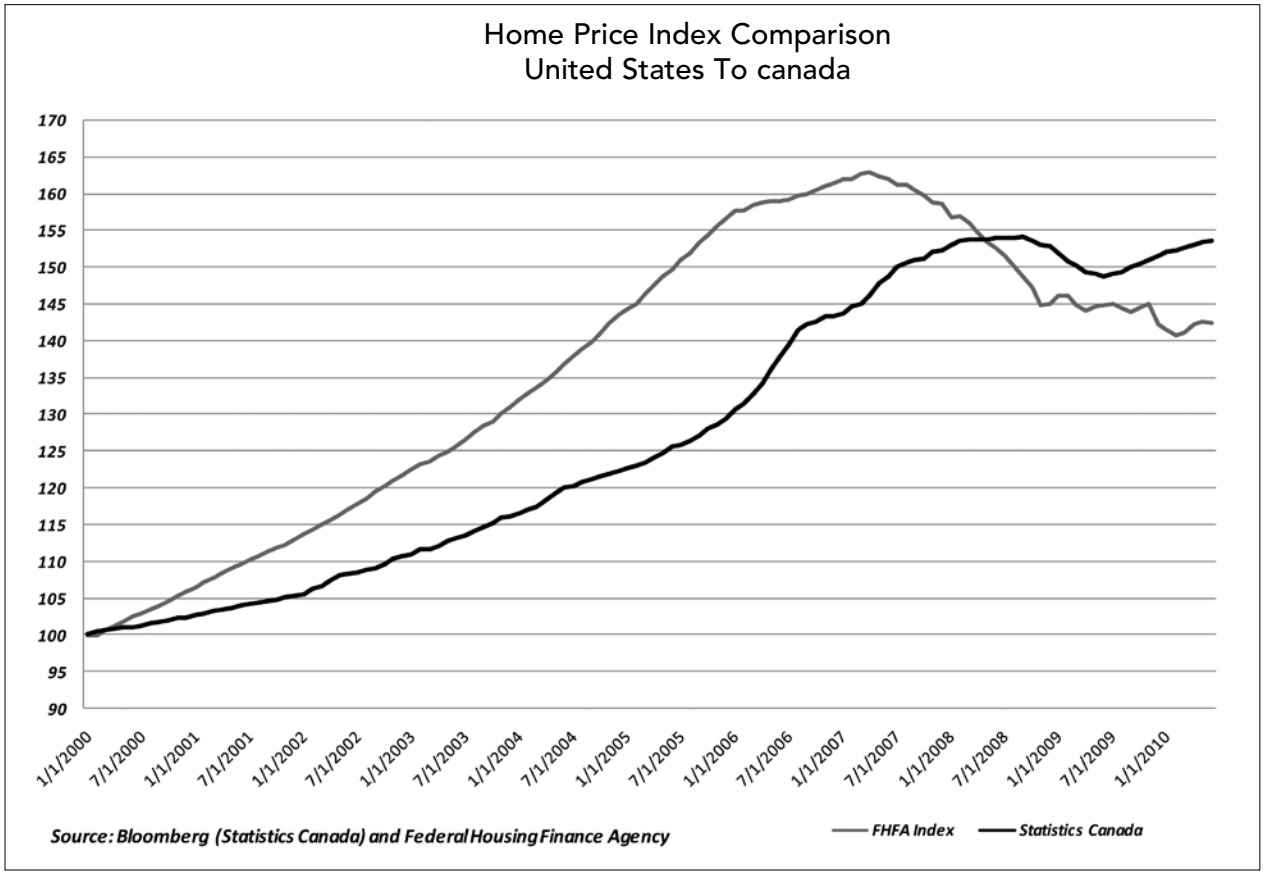
In Canada, securitization was much slower to catch on, and never reached the fever pitch it did south of the border. About $267 billion of outstanding loans have been securitized, representing 29 percent of all loans, according to a report by the International Monetary Fund.[1] Moreover, only $24 billion of those were private label (meaning they did not have a governmental guarantee), compared with $3 trillion in the United States from 2005 to 2007. This means Canadian banks tend to retain mortgages on the balance sheet for the life of the mortgage, instead of selling them to investors and jettisoning the risk.

Canada avoided a collapse in part by maintaining its historically tighter underwriting standards, which call for higher down payments, short- to medium-term fixed rate loans with a longer amortization period of 25 to 30 years following the fixed rate period (after which the rate resets to the market rate), and other enhanced underwriting requirements when compared to more recent U.S. subprime and Alt-A lending. Subprime lending remained a fraction of the U.S. pace, accounting for roughly 5 percent of the market in 2006, compared with 22 percent in the United States.[2] Its Alt-A segment remained small this decade, and the debt-to-income ratios used to underwrite ARMs assumed the average major lender-posted five-year rate as opposed to the U.S. method of using a current "teaser rate." While standards started to loosen somewhat prior to the U.S. subprime crisis, Canadian lenders were able to curtail lending in the category once they saw the disturbing outcome in the United States.

RETENTION OF RISK PROVIDES A SAFETY VALVE

When loans can be packaged and sold as bonds to investors, it creates more liquidity in the secondary market. Yet that benefit presents a weakness for the system. In the escalation of MBS volume, once the loans were securitized, they were removed from the balance sheet of the banks that originated them. In essence, U.S. banks and other originators could write very risky loans and not actually retain the risk, so long as they were able to securitize the debt. Banks earned money through origination fees and spreads above the interest paid on the securities. On the other hand, Canadian banks tended to retain the mortgages on the balance sheets. By carrying the risk, banks tend to be more responsible in their underwriting since the banks were exposed to the credit risk of the mortgages.

"THE UNITED STATES USED LOWER DOWN PAYMENTS AND TAX INCENTIVES TO REINFORCE ITS POLICY OF EVERY AMERICAN OWNING A HOME. CANADA INSTEAD SHUNNED INCENTIVES AND EMPHASIZED HIGHER DOWN PAYMENTS ..."



While the U.S. system created a property bubble and set the stage for a real estate crash, Canada's more conservative approach allowed it to avert a collapse itself. Its lag behind the United States in loosening of lending practices gave it a looking glass into the unraveling of the subprime market in America. By extending less mortgage credit to those with questionable income and credit Canada avoided skyrocketing property values, and the inevitable unwinding as was the case in the highly leveraged American market. The figure above summarizes the outcome of the two approaches to housing. The Canadian market did not appreciate as quickly as the United States' housing market from 2000 to 2006; however, the Canadian market also did not fall as hard as the United States' housing market and has resumed steady increases in property values.

CONCLUSION

Major differences between the U.S. and Canadian residential mortgage market range from the overall government policy and societal values to the drive of bankers to increase revenue. Given these differences, it appears very unlikely that there is a quick fix to the U.S. problems in the residential mortgage market. On the other hand, Canada's market strength during a global economic slowdown gives insight into adjustments that can possibly be made over time to the U.S. market.

Potential changes to the U.S. residential mortgage market could include a change in government policy away from the idealistic stance that every American should *own* a home; rather the United States may want to focus on ensuring every American has a place to live—either through ownership or rent. No doubt, strict and consistent underwriting standards—much of them back in place today—will help. Prudent securitization would also help preserve a more conservative approach, or at least minimize the chances of another period of writing loans—no matter what their risk—solely for the sake of securitizing them. Some of these issues are being partially addressed by the Dodd-Frank Act. The Dodd-Frank Act focuses on more prudent underwriting criteria and requires companies selling securities to retain 5 percent of the risk under certain conditions. In the longer term, a potential beneficial change could also involve a shift in social mindset in American borrowers that values maintaining less debt by putting down a higher down payment. ₫

END NOTES

1 IMF Working Paper: Canadian Residential Mortgage Markets: Boring But Effective? June 2009. p. 5.
2 "Why Didn't Canada's Housing Market Go Bust?" Federal Reserve Bank of Cleveland. December, 2009.

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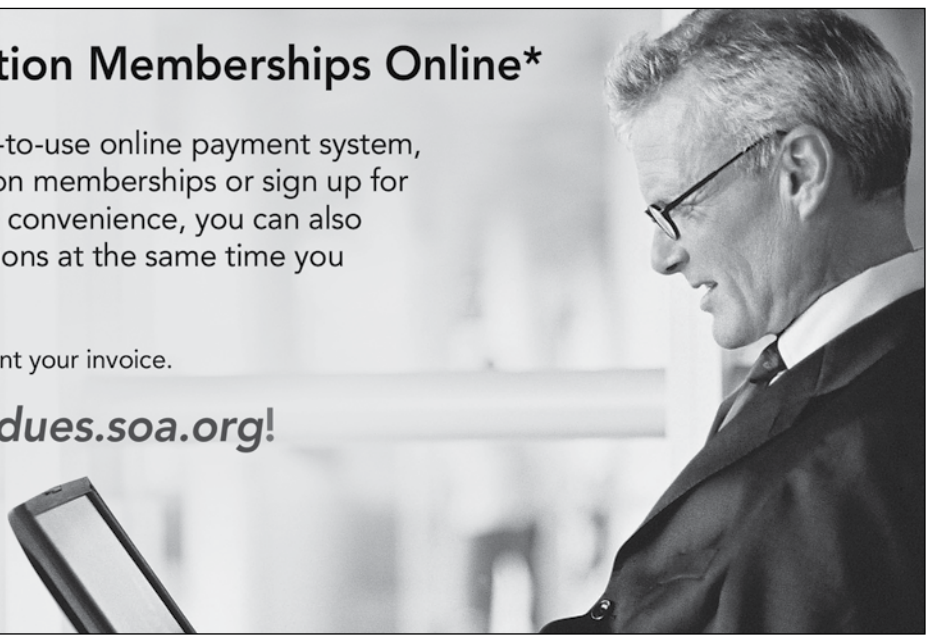

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