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Stochastic Model: A Telescope or a Kaleidoscope?

by Vivek Gupta

A telescope and a kaleidoscope both provide a view but that is where the similarities end. A telescope shows us an actual view whereas a kaleidoscope creates a view from broken pieces of glass. This article will analyze which analogy is closer to the stochastic modeling of interest rate or stock market projections.

There are two basic requirements to develop a stochastic model:

1. Sufficient and reliable historical data to determine variables for the model.
2. An unbiased system that, under certain assumptions, links those variables and randomly generated scenarios to create a range of projections.

Can these requirements be satisfied? The world is changing at such a speed that the historical data is not sufficient and reliable. When we make too many assumptions to create a system, it becomes biased. An examination of six important trends of our present time—and their impact on interest rates and stock markets—will prove this point.

Current Trends

1. Over supply of money in the world market.

An analysis of two crucial economic phenomena can be used to establish this important trend. First of all, interest rates are coming down in most of the world economies. This can only happen if the supply of money is more than the demand for money. Monetary policies or any other government intervention can control the interest rate shifts within a small range and only for a short period of time. The boom and the bust of NASDAQ is another example. Billions of dollars of speculative investments were made in a short period of time and every high-tech initial public offering (IPO) went haywire, a situation only possible because huge sums of money were looking for lucrative parking spots.

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2. Demographic changes

All of the western countries are experiencing major demographic changes. Birth rates are declining at accelerating rate. Fertility rates, except for in the United States, are below 2 percent. (The fertility rate of a country has to be at least 2 percent in order to replace its population.) People are living longer in these countries and, as a result of aging populations, effective dependency ratios are increasing as well.

3. Terrorism and wavering world peace

Relatively speaking, the last 50 years were the most peaceful years in world history. There were some small wars in Asia and Africa but no major war. This is unusual in human history.

4. The crash of the Japanese stock market

The Japanese stock market dropped by more than 50 percent approximately 10 years ago and has not recovered. Can similar setbacks occur to other major stock indexes?

5. Online trading

The Internet has revolutionized stock trading over the last five years. The cost of a trade is as low as \$10 and there is no intervention required by an agent. Currently, one third of personal trading is executed through online services.



6. Globalization

Globalization is evident everywhere. Most, maybe all, of the clothes I buy are made in China. Most of the fruits and vegetables we eat come from Mexico and Chile. The next time you call a customer service line, the phone may ring in India.

Are these trends permanent or temporary?

If these trends are temporary, they can be easily ignored in our projections. But if they are permanent, we need to know the likelihood of these trends continuing.

1) Oversupply of money in the world market

A technological break—through with widespread application—like the introduction of electrical power in the early 1900s or the introduction of computers later in the same century—can help absorb the excess supply of money in the world. Recently, major advances took place in the fields of nano—technology and biotechnology. These sectors will have widespread applications and will add an abundance of high paying jobs to the western economies. Of course, that will require the manufacturing of high-tech equipment and the engine of the world economy will churn again. But these technologies are still in the laboratories—the way computers were in the 1950s and 1960s. So we can assume that it will take 15 to 20 years before these new technologies will start entering our homes in the way computers did in the 1980s.

Until plenty of high-profit investment opportunities are available in the manufacturing of innovative products, it is highly likely that this particular trend will continue.

2) Demographic changes

The fertility rates in the western countries have been declining over the last three decades and will continue to decline. A look at history and the evolution of the human species helps explain why this is so. The way I see it, our species is quite selfish. Humans wanted, or needed, children mainly for two reasons. First of all, children were the parents' only source of food, shelter and defense in their old age. Secondly, people saw their own growth in the growth of their children. The younger and able people, to a large extent, took care of their elderly creating a circle of life through mutual dependence.

Today, the working population knows that it cannot financially depend on the next generation and should save for its own old age. The working population also knows that they are not taking care of their elderly very well either. No doubt they are financially providing for the elderly population through the tax system but the direct care of the elderly is less and less of their responsibility.

At present we are experiencing a phenomena of baby boom echo in North America. That is, baby boomers are passing through the age of fecundity. Even still, the current fertility rate is 1.6 percent in Canada and barely 2 percent in the United States.



We can also look at some of the current social trends to see how the fertility rate will pan out in the future.

- The family structure is under tremendous pressure and is crumbling. In the past, families stayed together out of necessity. However, due to the continuous prosperity of the recent past, there are enough resources that each individual can afford to live on his or her own.
- With the availability of affordable birth control methods, more and more men and women are voluntarily deciding not to have children.
- Statistics report that almost 50 percent of the children in North America do not live with their biological set of parents. When these kids grow up, they will be the least likely to start a family and have children.

Low fertility rates seem like a natural result of continuous prosperity.

The fertility rates in the western countries have been declining over the last three decades...

3) Terrorism and wavering world peace

If someone was to ask me if the next 50 years are going to be as peaceful as the last 50 years, my answer will still be in the affirmative. But, five years ago I would have given the same answer with more confidence. The know-how and ability to use nuclear weapons is increasing. The religious and the economic rivalries are increasing in intensity. Given today's political situation in the world, things do not look that positive, so there is less likelihood of peace which we are accustomed to.

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4) The crash of the Japanese stock market

The economy of Japan flourished after World War II by exporting electronic goods and cars to the rest of the world. For years, the Japanese economy reaped billions of dollars of surplus and the Japanese people enjoyed the highest level of disposable income.

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But the dragons and tigers of the Far East in the mid-1970s challenged the dominance of the Japanese superiority. Along with clothes, Hong Kong started producing electronics at much lower cost and the quality of goods made in Hong Kong was also very competitive. In order to stay competitive, the production of brand names like Panasonic, Toshiba and Hitachi was moved from Japan to Taiwan, Korea and China.

Are these production lines going back to Japan? I don't think so, because the economic and natural factors are so strong. China has a large trained work force that is willing to work at a much lower cost than their Japanese counterparts. The availability of natural resources and slack environmental laws make it easier for manufacturing. When investors from all over the world are looking for someplace to invest, capital is not a problem either. In spite of the political problems of the past, the Chinese government is also playing a constructive role in the development of the country.

By the mid-1980s, due to the oversupply of money, the interest rates in Japan touched the ultimate floor: zero percent. The industrial over-capacity was well beyond healthy levels. Real estate prices were bulging. Yet, politicians and investors did not want a soft landing and

kept blowing the bubble. Investment in the manufacturing sectors is considered to be the most important signal of the future prospects and it propels the economy in the shortterm. So, more and more money was poured into such investments without any rigorous economy analysis. Any cost-benefit analysis is not difficult at all when the interest rates are zero. So, more and more money was poured into such investments without any rigorous economic analysis. These investments did not return profit and soon turned into bad debts. Inevitably, the bubble burst. So far, all the political and economical efforts to patch the bubble have been unsuccessful.

Still, there is one highly favorable aspect of the Japanese economy. Japan invests, as a percentage of its GDP, in research and development more than any other country in the world. With a new breakthrough technology, which has mass application around the globe, the Japanese economy can add new manufacturing lines and abundance of high-paying jobs. Until then, most likely, the Nikkei will keep deflating.

5) Online trading

The Internet is becoming cheaper, faster and more widely available. One can browse the Internet over a cell phone and execute a trade. This is the way to go.

6) Globalization

The international trade barriers are coming down around the globe. The Internet and TV are becoming more affordable everywhere. More and more countries are becoming familiar with distant cultures, which was not possible before. Means of communications are becoming cheaper and more widespread. More and more geographical efficiencies are exploited in agriculture, manufacturing and trade.

There is another question: Will the political boundaries be able to contain the new technology? It does not seem that way. Take, for example, cell phones. When they came out in early 1980s, they were made in the US or Japan. Today most of the cell phones are made in China or Taiwan. The reason that happened in such a short period of time is that the major cell phone companies wanted to bring the cost down. A wider consumer base was necessary to create a good enough critical mass to set up networks. So those companies took the technology to the low cost regions of the world. Globalization is the way to go.



Current/potential impacts of these changes

1) Oversupply of money in the world market

The number-one effect of this phenomenon is that interest rates will stay low. The fundamental forces of economics will kick in and will rebalance the supply and demand. This situation in North America is quite similar to the Japanese experience, so low profit investments will be made here as well. That will absorb some of the oversupply of money. After some time, commercially viable applications of nano-technology and biotechnology will show on the horizon. They will provide opportunities for high profit investments and will create new demand for money. The overall result, I believe, of current low profit and high-risk investments will send the stock market indexes lower over the next decade or so.

2) Demographic changes

In the last 20 years, baby boomers saved a lot of money and invested in stocks, mutual funds and in fixed-income vehicles. In order to provide fixed return to the depositors, the banks had to lend money to businesses. There was a buying pressure on the stocks and the businesses

had an abundant supply of funds. We all know that concept is changing. Large cohorts of baby boomers are going to retire in the next few years and will start withdrawing their deposits. Due to the larger swing in the birth rates, relative to the American birth rates, this change is especially important for Canada. So in a few years, the buying pressure is going to change into a selling pressure.

The supply of labor will also shrink when baby boomers begin to retire. No doubt, new immigrants will fill some of that gap but will not fully replace all of the retirees. Again the law of supply and demand will show its strength and the cost of labor will increase. The demand will be adjusted with North American production lines becoming less competitive and moving to low cost areas. Overall, demographic changes will cause a downward trend for the equity markets.

3) Terrorism and wavering world peace

Deteriorating world peace will add uncertainty to the economic prospects of countries. We observed the excessive volatility of the markets during the second Gulf War. After the September 11 attack,

the stock market analysts were forced to consider at least some catastrophic scenarios in their projections so their stock valuations are down. More uncertainties will lower their valuations further.

4) The crash of the Japanese stock market

Are North American stock markets going to experience something similar to the Japanese market (i.e. a permanent correction)? An analysis of similarities and differences of the two markets can help us answer this question.

One obvious similarity is that North American politicians, investors and analysts are following in the footsteps of their Japanese counterparts. The evidence of the political will to boost the stock markets in the shortterm can be seen in unprecedented tax cuts. The economic and international factors faced by Japan are also faced by North America.

The former has quite a few advantages over the latter (for instance, the availability of natural resources, the sheer size of the consumer base). Japan is highly dependent on North America for the consumption of its massive industrial production. The status of the sole super power definitely adds strength to the American stock market. The flight to quality will also help sustain the other downward pressures. All the major stock markets are following the American trends and their correlation factors are steadily going up. The balance of cost and benefits of international diversification will shift. The portion of capital outflow from North America, which is occurring just to achieve diversification, will slow down to a large extent and will support the market at home.

Clearly, North American markets are better off relative to the Japanese markets. The bubble of North American

stock markets is not going to burst like the Japanese market; it will just deflate to some degree. Overall, a large number of forces are tugging these markets in different direction all the times and that means more volatility.

5) Online trading

In the pre-Internet days, one had to talk to an advisor before executing a trade. So the advisor could give his/her input before the execution and could dissuade the investor from making a hasty decision. Now there is less control on the investor against over reaction. As a result, we are observing more volatility in the stock markets. With more investors choosing to trade online, the stock market volatility is bound to increase.

6) Globalization

The most important influence of globalization is that quite a few non-western economies are rapidly progressing on the path of prosperity. Asia used to be a net importer of not only the manufactured goods but also of agriculture items. Today, most of the Asian countries are self-sufficient in their food requirements and are the net exporters of manufactured goods. Of course, the developing world is importing high-tech items and heavy machinery and exporting labor-intensive and low-tech manufactured goods. However, that balance is tilting. Globalization will put downward pressure on the major stock markets. No wonder, for the first time after the great depression of the 1930s, the federal reserve board is worried about deflation.

Up to this point, this article has examined two concepts:

1. History is history. The world is changing at such a fast pace that history is not relevant any more.
2. Major changes are happening and have

a definitive effect on the stock markets and interest rates. When and how much they impact the stock markets is highly uncertain.

Limitations of a stochastic model to project stock market behavior

1. The historical data do not include the impact of current changes. For example, the Toronto Stock Exchange (TSE) was established in 1952. Even if we use the entire TSE data, it will not include the effects of the Second World War on the stock market. No matter which statistical theory is applied to hammer the invalid data, the variables it churns out are not going to be meaningful. Any model that does not include the effects of the above-mentioned six points will be no more than a naive attempt. These trends are not moving in a purely random fashion. To incorporate their impact in a stochastic model someone has to make educated guesses. When a model is based on so many biased assumptions and apprehensions, how can it generate “pure” projections?
2. Any attempt to develop a correlation of all the variables affecting the stock market will not be more than a random guess. The impact of each variable is uncertain, so their combined uncertainty will be too large. The range of outcomes in a short period of 10 to 15 years could be more than six times of its mean.
3. What can one decipher from such uncertain results? Can a mean of such a range be a meaningful number? Obviously not! Any other statistical measure (for example 95 percent CTE or 99 percent VAR) will not be more than a guess squared.
4. When the range of stock market outcomes is so large, it means the range of the liabilities of a block of variable annuity is also very large. It is so difficult to match assets to a single stream of liabilities over the next 20 years. How do we match assets with such a wide range of liabilities?
5. Let us assume, somehow, we developed a “perfect” model to reasonably simulate the market behavior with 1000 iterations. What is stopping a company from running multiple cycles of 1000 iterations, selecting a cycle with “the right” answer and discarding the cycles with not so good answers? The right answer could be a lower level of reserves or a better match of liabilities with assets! That way, any low probability outcome could be mistakenly conceived as the most likely outcome. Is it not a wide-open legal loophole?

Proper application of simulation

1. Over a very short period of time

Banks use stochastic modeling to calculate VAR over the next 10 days. That is fine. One can have a reasonably high level of confidence in the assumptions for that short period of time. Insurance companies not only need projections over the next 20 or 30 years, but also those projections have to be based on highly uncertain assumptions on lapse rates and consumer behavior.

2. For a known scientific phenomenon

A flight simulator uses the stochastic modeling in the best manner. The developers of a simulator know exactly how a plane behaves in a particular scenario. Basically, they just recreate past behavior.

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Any alternative?

One answer is conservative deterministic scenarios. In order to remove individual biases from these scenarios, organizations like SOA and CIA can set up a committee to conduct a delphi study on a periodic basis. This group can be responsible for collecting comprehensive data, completing in-depth analysis of the data and applying its collective wisdom to generate a reasonable number of deterministic scenarios.

The choice between a stochastic valuation and a deterministic valuation is like choosing between “playing with fire or letting the fire play with you.” Personally, I would play with the fire rather than let the fire play with me! That way I will be in charge and can stop playing with the fire when it starts burning me! But if the fire is in charge, it will not stop when it becomes unbearable to me. It is a choice between bad and worse.

Is using deterministic valuation methods like playing with the fire?

I think so because, when we are setting deterministic interest rate scenarios, we are basically trying to do something that is clearly out of bounds for humans. We actuaries are still humans and none of our five senses can explore the future. There is no trace of any mythological globe that tells the future. So, based on what we read and what we hear, we guess. At the most, we use our sixth sense. Some make conservative and some make aggressive guesses. It very well can be biased because we, as humans, always like what we perceive to be good for us.

Is using stochastic valuation methods like letting the fire play with us?

I think so. We let the computer guess the future for us because we know that our guessing ability is limited and we can be biased. At least, it will not be biased. It will project values based on a large number of unbiased

scenarios and give us the desired statistical value. This value could be an average or a Conditional Tail Expectation. Note: “CTE” cannot be used by itself. At least it has to be “a CTE measure.” So, did the computer enhance our ability to project the future interest rates?

I do not think so. A computer does what we program it to do and thereby it inherits all our limitations. We make it guess based on our biases. We tell it that the interest rates are going to mean revert. Either it will calculate the mean as we tell it to or we just hard code the mean. All it does is extrapolate the past based on the coded assumptions.

Even though we know very well that the future is going to be different from the past, still we put very high confidence in the outcomes generated by the computer. Somehow we end up following the black box blindly and we let our guards down. That is why I believe we are letting the fire play with us.

Conclusion

In a nutshell, I believe a stochastic model to project interest rates or stock market behavior is like a kaleidoscope rather than a telescope. A kaleidoscope, made with some broken pieces of red glass, will create a view with some shades of red, no matter how many times you turn it. Let us not navigate our ships through rough waters by mistaking a kaleidoscope for a telescope. ☺



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