RETIREMENT PLANNING

Modeling The Sustainable Withdrawal Rate

By: Jim C. Otar

One of the goals of financial planning is to provide individuals with realistic retirement projections. However, this can be a difficult task given that the available models – Straight-line Growth and the Monte Carlo simulation – fall far short of this goal.

So what can a sponsor do to ensure their members retire with adequate income in retirement? Before you can determine if there is a better method, the existing models should be examined.

As the name suggests, the straight-line model is based on constant growth of the markets over the lifetime of the portfolio. It is the most commonly used model for both accumulation and dispersal stages of the portfolio. A typical projection of assets is shown in *Figure 1*.

In research for my book, *High Expectations & False Dreams – One Hundred Years of Stock Market History Applied to Retirement Planning* (ISBN: 0968963404), 100 years of historic data between 1900-1999 shows that straight-line models overestimate the portfolio life between 85 per cent and 90 per cent of the time. *Figure 2* shows the portfolio value of a balanced portfolio consisting of 40 per cent equity and 60 per cent fixed income, rebalanced annually, with the equity portion of the portfolio outperforming the underlying index by 1.5 per cent each year, and a six per cent initial withdrawal rate.

The red line on the chart shows the projected portfolio value during retirement years (dispersal period) using the straight-line projection model. Each one of the black lines shows the portfolio value based on the actual market performance and the rate of inflation, if one were to retire at the beginning of 1901, 1902, 1903, and so on for the 100 years of the study period. In this particular case, the portfolio outlasted the projection of the standard financial plan after 30 years in only seven out of potentially 70 cases.

Similar patterns were observed for different initial withdrawal rates between two per cent and 10 per cent, various asset mixes, equities outperforming the underlying index (DJIA) between +4 per cent and –4 per cent, as well as rebalancing at different time intervals.

Why is the straight-line model so far from historic reality?

To understand this, we have to look deeper into how markets work on retirement portfolios. We have to clearly differentiate between what affects the *market value* of a portfolio (the vertical axis) and what affects the *longevity* of a portfolio (the horizontal axis).

The three factors that influence the market value of a portfolio are mega-trends, market cycles, and random fluctuations.

There are also three factors that influence the longevity of a retirement portfolio:

- the timing of the start of the retirement relative to the market cycle
- reverse dollar-cost-averaging
- inflation

Keep in mind, unless cash is taken out of the portfolio periodically, the factors that influence the market value have no effect on the portfolio longevity.

Market Cycles, Mega-trends

Stock markets do not grow in a straight line. Neither do they move at random in the long term. Since 1854, an average business cycle lasted 53 months. The average bull market was 35 months and the average bear market was 18 months in duration. Between 1945 and 1991, the average bull market was 50 months and the average bear market was 11 months.

Compounding matters, there is also a phenomenon called 'mega-trend' – an extended bull or bear market that is unusual in its severity or longevity. During the last century, we had three mega-bull markets. Two started after the end of each world war and the third started when the cold war between the U.S. and Soviet Union showed signs of ending in 1982.

A mega-bear market followed each of the first two mega-bull markets. We have yet to see if the bear market that developed after 1999 develops into a full-scale mega-bear market. Each new generation of investors experienced at least one mega-bull market followed by a mega-bear market in their lifetime during the last century.

Mega-bear markets can have a devastating effect on retirement portfolios for several reasons including:

- periodic asset rebalancing speeds up depletion of the portfolio
- the retiree doesn't have the means to replenish the losses
- the time horizon (the remaining life expectancy of the retiree) may be too short to allow for a meaningful recovery.

To understand the effect of a bear market on a retirement portfolio (a retirement portfolio is defined as an investment portfolio with regular, periodic withdrawals), we need to look at 'reverse dollar-cost-averaging (DCA).'

Reverse Dollar-Cost Averaging

Let's look at an example of reverse dollar-cost averaging (*Figure 3*):

Say you hold an investment that goes through a bear market cycle. The share price first goes down and then goes back up. In this example, you initially invest $500 and then periodically withdraw $60 from this investment. Initially, the share price is $10. During the bear market the share price goes down. From there, it gradually recovers back to $10.

How much is the loss? Because we had to sell more shares when the price was low for the same $60 periodic withdrawal, when the price went back up to $10, we had less shares to participate in the rise. At the end of the cycle, we read from the last line

that our total cost is $260, the total market value is $213, and net loss due to Reverse DCA is a whopping 18.1 per cent.

Granted, this particular example may be somewhat extreme. However, it is easy to see that a good portion of a retirement portfolio can be depleted because an average retiree, in all likelihood, will endure three or four bear markets during their retirement.

The timing of the start of the retirement relative to a market cycle has one of the largest influences on the portfolio life. It is not unusual to lose 35 per cent to 40 per cent of the portfolio life if one retires at the beginning of a bear market instead of a bull market.

Figure 1 **STRAIGHT-LINE MODEL**

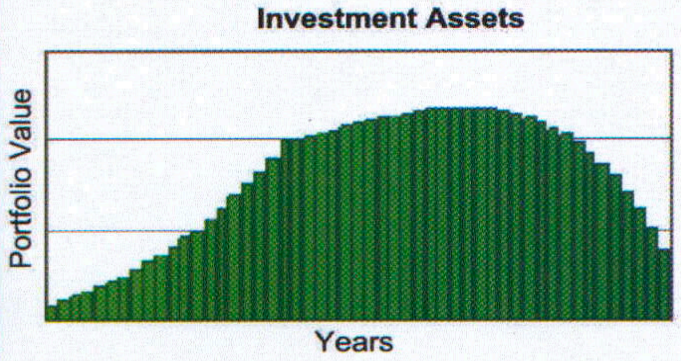
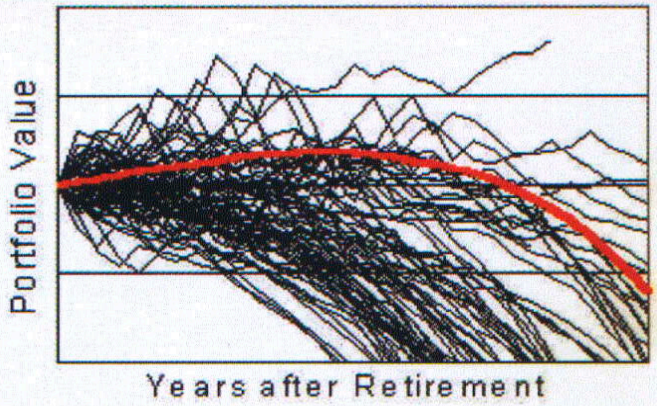


Figure 2 **PORTFOLIO VALUE***



*(40 per cent equity, 60 per cent fixed income, rebalanced annually, 1900-1999, equity return DJIA+1.5 per cent)

Inflation

You may have some control over when you retire with respect to market cycles or you may work part-time for a few years after your retirement. But several years later, you may no longer have these choices. This is when inflation hits you, when you are most vulnerable.

Over time, inflation is a real portfolio buster in two ways.

Initially, you withdraw more and more from your investments to meet your increasing living expenses. Then, to fight inflation, central banks occasionally increase short-term interest rates. This invariably pushes down share prices which, in turn, reduces the value of your investments at least temporarily. In the final analysis, not only do you end up withdrawing increasingly larger amounts from your investments, but you do so from a shrunken asset base.

It was because of the inflation effect that a retirement portfolio lasted longer if one retired at the beginning of the market crash of 1929 (19.7 years) than at the beginning of 1966 (16.7 years). The years between 1966 and 1982 were a period of higher inflation.

Using an average, straight-line inflation rate in retirement models leads to an overestimation of the portfolio longevity. However, there is not much one can do other than to hope that in the future, the central banks continue to keep inflation in check. Other remedies for a retiree may include holding some inflation-linked bonds and some hard assets.

In addition to cyclical mega-trends and market cycles, share prices fluctuate randomly. Simulations using the market-cycle model (which is explained later) show that random fluctuations increase the portfolio life by as much as 9.4 per cent and, at worst, decrease it by 7.5 per cent. So random fluctuations, although not a large contributor to the longevity of your portfolio, do make a difference.

Monte Carlo Simulation Model

Some newer financial plan models are based on the Monte Carlo simulation. Unlike the straight-line model, the Monte Carlo model adds randomness to straight-line growth.

While Monte Carlo models can work well with random fluctuations, they do not handle the effects of market cycles. To circumvent this difficulty, the range of randomness is increased to a point where it broad-brushes all cyclical market moves. Doing so only covers up this difficulty. It does not solve the underlying short-coming that Monte Carlo simulation is based on statistical randomness around a straight-line trajectory. In the long term, markets are neither random, nor do they follow a straight path.

Obviously, a better retirement model is needed.

The straight-line model uses an estimated future growth rate of the markets. This growth rate is based on a combination of factors such as historic experience, expected future returns, and the exuberance of the investor or advisor.

A 'market-cycle' model divides the straight-line into a series of two 'legs' – the bull market and the bear market. Each of these legs is based on its own average historic performance and duration. These zigzagging 'building blocks' handle the consequences of market cycles and reverse-dollar-cost-averaging in a retirement portfolio significantly better than the straight-line model. Our market-cycle model consists of 16 quarters of bull market followed by four quarters of bear market to approximate the historic average.

Over time, if there are no withdrawals from the portfolio, both the straight-line

Figure 3 **REVERSE DOLLAR-COST AVERAGING**

Share price $	Invested $	Total cost $	Number of shares bought (sold)	Share balance	Total market value $
10	500	500	50.0	50.0	500
7	-60	440	(8.6)	41.8	290
8	-60	380	(7.5)	33.9	271
9	-60	320	(6.7)	27.3	245
10	-60	260	(6.0)	21.3	213

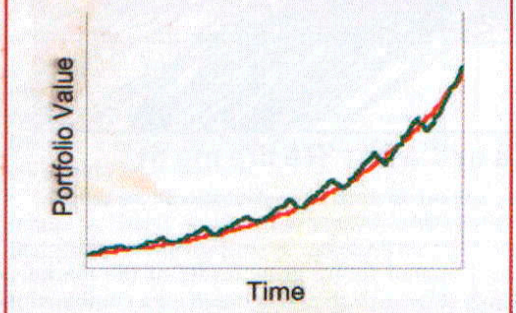
model and the market-cycle model have somewhat similar portfolio values as shown in *Figure 4*. When periodic withdrawals come into the picture, the portfolio values will diverge with time as shown in *Figure 5*.

However, there are still factors such as the randomness of the market and the randomness of timing the start of retirement.

The randomness of the market can be handled easily using a random number generator within a specified range. This is then superimposed onto the market cycle projection as shown in *Figure 5*.

Figure 4

PORTFOLIO VALUE*
Based on Straight-line and Market-cycle Model



Straight-line (Red)
Market-cycle Model (Green)

The randomness of the timing of starting one's retirement can also be handled with ease. Since we cannot foretell whether one is retiring at the beginning of a bull market or a bear market (or anything in between), we can make our projection based on both (use one projection assuming retirement at the beginning of a bull market and another at the beginning of a bear market, as shown in *Figure 5* with green and blue lines, respectively). This provides us with a range of possible outcomes.

The market-cycle model appeared to be a sensible model and it worked better than the straight-line model. However, it needed further engineering because its results were not entirely congruent with 100 years of market history. Factors such as mega-trends, skewness of market volatility, and significant variations of inflation did influence the outcome such that it had to be modified to reflect the empirical data. We call this modified model the 'True Market Model.'

True Market Model

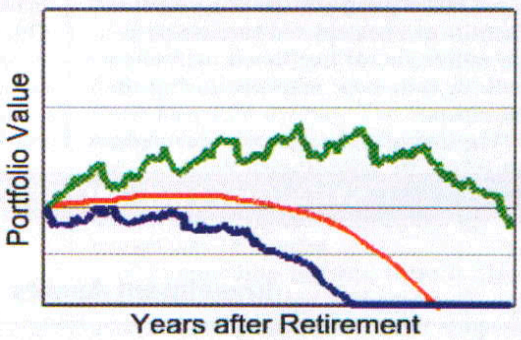
With the market-cycle model, we had three areas of divergence from real-life:

- In the market-cycle model, retiring at the beginning of a bull market (*Figure 5*, green line) projected a portfolio value that was significantly larger than the straight-line projection (*Figure 5*, red line). In fact, this rarely happened in real-life over the long term. Therefore, we decided to use the straight-line model as the 'best-case' scenario, which occurs 10 per cent to 15 per cent of the time, in the True Market Model,.
- If one retired at the beginning of a bear market, the market-cycle model projected an overly optimistic portfolio life (*Figure 5*, blue line) compared with the historic experience. This is so because of the effects of mega-bear markets and/or bouts of high inflation. Consequently, the worst-case projection was adjusted to reflect the actual experience of the 100 years of market history in the True Market Model.
- The third observation was that in real life, most portfolio values over the 100 year study period were concentrated near the one-third distance from the worst-case line between the best-case and worst-case lines. While statistical conveniences such as 'average' or 'median' have little meaning in one's retirement planning, nevertheless this 'centre of gravity' was indicated as the 'typical' portfolio value, because lack of such notation might lead an observer into thinking erroneously that the 'average' is halfway between the best and the worst case.

These three observations allowed us to improve the theoretical market-cycle model and build the practical True Market Model. *Figure 6* depicts portfolio value projection based on this True Market Model.

Figure 5

PORTFOLIO VALUE*
Based on Retirement Timing



Green: Retire at the beginning of a typical bull market
Blue: Retire at the beginning of a typical bear market
Red: Straight-line model

Now we have a complete retirement portfolio model (to download, visit www.cotar.org) that addresses the effects of market cycles, reverse dollar-cost-averaging, mega-trends (in terms of minimum and maximum portfolio life), inflation, and random fluctuations. Now, we can give realistic projections to plan members instead of trying to dazzle them with statistical wisdom. ■

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Figure 6

TYPICAL OUTPUT OF THE TRUE MARKET MODEL