Understanding Variable Annuities with GMWBs  
(and the flaws in Ibbotson’s analysis)  
By Robert Huebscher  
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Peng Chen’s response to this study is published here.

It’s very tempting: a variable annuity with minimum lifetime payout that can increase – but never decrease – based on market performance. You don’t even have to annuitize; if you die or terminate the agreement, you or your heirs receive the remaining contract value.

That temptation comes in the form of an increasingly popular variable annuity (VA) rider known as a guaranteed minimum wealth benefit (GMWB).

I became interested in this product because of a widely publicized study by Peng Chen and his colleagues at Ibbotson Associates. Chen’s research, which was funded by Nationwide Insurance, has been published in the Journal of Financial Planning and presented at industry conferences.

Because its performance is tied to market performance, the VA+GMWB is a complex product. In order to understand it, I will look at a key issue that was not addressed in Chen’s study: the amount and cost of the longevity insurance a VA+GMWB provides. But first I will turn to Chen’s central thesis, namely that an investor can reduce longevity risk – and increase income – by taking a portion of the fixed-income assets in a retirement portfolio and replacing them with a VA+GMWB. That thesis is wrong, as I will demonstrate.

The VA+GMWB is not a bad product, and it is not my intent to discourage its use. An investor who understands its costs and benefits in the proper analytical framework may find the VA+GMWB useful. It is my intent to provide that framework.

Michael Edesess, who has a PhD in advanced mathematics and economics, helped design the framework to study this product. He is a visiting fellow at the Hong Kong Advanced Institute for Cross-Disciplinary Studies, as well as a partner and chief investment officer of Denver-based Fair Advisors. Louis Mittel, a research assistant with Advisor Perspectives, built the Monte Carlo model for this study.

A more detailed description of the VA+GMWB is provided in an appendix at the end of this article. At a high level, it is an annuity that pays a minimum lifetime withdrawal amount with the added benefit that the amount can increase based on the performance of its subaccounts. It also pays a death/termination benefit equal to the remaining account value.
The flaws in Ibbotson’s study

Let’s turn first to Peng Chen’s study. Chen is the president of Morningstar’s Global Investment Management Division. His responsibilities include overseeing the research of Ibbotson Associates, which is a subsidiary of Morningstar. Chen’s results deserve scrutiny because of Morningstar’s stature in the investment industry and because many potential investors will rely on them.

In his study, Chen replaced a portion of the fixed-income component of a hypothetical retirement portfolio with a VA+GMWB. He compared the original portfolio to the resulting portfolio using several metrics, including total income, income return (the percentage change of income from year-to-year) and semi-deviation (the standard deviation of negative income returns). On all counts, the resulting portfolio was superior, leading Chen to conclude that the “VA+GMWB offers protection both in terms of market downturns and more importantly retirement income risk.”

Chen used Ibbotson’s projected capital market returns for his study, which included an expected return for bonds of 4.36%; this represented the income (as a percentage of principal) in the original portfolio. The corresponding income from the VA+GMWB was a minimum of 5% of the principal, and this amount can increase (but not decrease) based on market performance. Thus, it was a foregone conclusion that the portfolio containing the VA+GMWB will score better on all three metrics, as Chen’s study verifies.

Chen’s thesis, however, is based on flawed methodology and has limited, if any, practical value.

First, Chen considered only one scenario – that where the investor lived to age 90, which has a probability of approximately 19%. His analysis, unlike ours, does not take into consideration mortality and the possibility that the investor might not live to age 90. Had he considered mortality, he would have replicated our analysis.

In an email exchange, I asked Chen about his decision to ignore mortality in his analysis. He said he was modeling an investor who was “moderately risk-averse,” by which he said he meant an investor who was concerned about outliving their assets at age 90.

But this is a severely incomplete approach. It is analogous to purchasing insurance against an event that has a 19% probability, and then examining only that scenario, as if it had a 100% probability. Only by examining the full range of scenarios with a mortality-based framework can one understand the costs and benefits of the VA+GMWB.

Second, in his robustness check, Chen considered the sensitivity of his results to changes in the fee structure and in the equity/fixed-income allocation. Given his metrics, however, the most important variables to consider would have been the expected return for the fixed-income component of the portfolio and the initial payout percentage for the annuity.
The relationship between those two variables will drive income tradeoff in the portfolio with and without the VA+GMWB, and anyone who relies on Chen’s study should analyze this carefully.

By examining only a single mortality assumption and ignoring the sensitivity of the VA+GMWB to changes in his assumed fixed-income return and annuity payout percentage, Chen has provided a narrow analysis that has little, if any, applicability.

The only relevant question when considering the purchase of a VA+GMWB is whether the longevity insurance provided by its guaranteed lifetime income is worth its cost. That decision is unique to every investor, and we have provided the framework to make that choice.

**Modeling the product**

Chen’s analysis was based on a “generic” VA+GMWB, not Nationwide’s product. We chose to analyze Nationwide’s Income Architect product. Its key features turned out to be identical to those in Chen’s study, with one important exception – the initial withdrawal percentage is currently 4.5%, not 5% as in Chen’s study. We assumed that the investment would begin at age 60 and withdrawals would begin immediately.

To estimate the cost and benefits of the longevity insurance provided by this product, we compared its returns to those of a passively invested portfolio. In other words, instead of investing $1 million in a VA+GMWB, one could choose to invest those funds in a similarly allocated passive portfolio.

We modeled a 70% equity/30% fixed portfolio, because that allocation provides the maximum benefit to the owner of the VA+GMWB. The probability of the withdrawal amount increasing from its base value is greatest with the most aggressive equity allocation, and the maximum permitted by Nationwide is 70%.

The fee structure of the Nationwide VA+GMWB that we examined was identical to that in Chen’s study. Those fees are 2.4% applied to the contract value and 0.6% applied to high-water mark reached by the contract value (the contract base), resulting in fees in excess of 3%. The passive portfolio had 1% fees, reflecting expense ratios and advisor fees.

As in Chen’s study, we ignored any risk that the insurer might default.

We ran a Monte Carlo simulation using the same capital market assumptions as in Chen’s Ibbotson study. In each iteration, we chose a randomly determined life span based on current mortality tables. That we modeled mortality and Ibbotson did not is a critical difference between the studies, a point I will return to later.
We used the passive portfolio to replicate the cash flows from the VA+GMWB, based on the terms in Nationwide’s prospectus and rider, which are summarized in the appendix. Our goal was to determine the probability that the investor could obtain those identical cash flows from the lower-cost passive portfolio. If the passive portfolio depleted, that indicated that the VA+GMWB was superior in that scenario.

The passive portfolio represents the opportunity cost of investing in a VA+GMWB; it has risk and return characteristics that are identical to the underlying sub-accounts of the VA+GMWB and can be used to replicate its cash flows. Only by considering the probability of the VA+GMWB outperforming the passive account – under the full range of mortality scenarios – can one assess the costs and benefits of the longevity insurance provided by the annuity.

**The results of our model**

We computed the internal rates of return (IRRs) for the VA+GMWB and the passive portfolio, taking into account all cash flows – withdrawals from the VA+GMWB, income from the passive account, and the ending balances in the passive and VA+GMWB accounts. We ran 100,000 simulations, each to a randomly chosen date-of-death based on mortality tables. Averaging the IRRs over those simulations, the results were as follows:

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<thead>
<tr>
<th></th>
<th>IRR</th>
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<tbody>
<tr>
<td>VA+GMWB</td>
<td>4.08%</td>
</tr>
<tr>
<td>Passive portfolio</td>
<td>5.65%</td>
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One of the virtues of the VA+GMWB is that it offers a 4.08% IRR; it would not be hard to find variable annuities that offer zero or even negative IRRs. But it still lags behind the passive portfolio’s returns.

While this 157 basis point difference provides a general indication of the relative advantage of the passive approach, however, it lacks mathematical precision, since IRRs cannot be averaged over different time horizons. The appropriate view is of the IRRs based on life span:

**Figure 1. Median internal rates-of-return (IRRs) for VA+GMWB and passive strategies**

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This figure shows the median IRRs for various life spans, from 61 years up to well past 100.

The overall IRR advantage of the passive portfolio is not surprising, and the lower IRR of the VA+GMWB reflects its higher fees and the cost of the longevity insurance for the scenarios in which the investor would outlive the passive portfolio. The VA+GMWB investor sacrifices overall return in order to insure against longevity risk. The passive strategy has a higher IRR for all life spans through 113.

While these IRRs compare the investment properties of the VA+GMWB to the passive portfolio, they do not provide the necessary framework for an investor to assess the cost of the longevity insurance. That assessment must be based on life expectancy, the probability that the passive portfolio would deplete, and how much insurance the VA+GMWB provides in those instances.

Below are the probabilities that the passive portfolio will match the cash flows of the VA+GMWB.
Figure 2. Probability the cash flow from the passive portfolio will equal that of the VA+GMWB

The passive portfolio has a near-100% chance of survival (i.e., not being depleted) until age 73, after which that probability slowly diminishes.

This tells only part of the story, though. We must also consider the amount of income that the VA+GMWB will provide in those instances where the passive portfolio is depleted. This is shown in the graphs below:

Figure 3a. Median average income for the VA+GMWB based on life span
Figures 3a and 3b show the median average and terminal nominal and inflation-adjusted income for the VA+GMWB based on life span. Initially, the nominal income is $45,000, based on the payout percentage of 4.5%. For the inflation-adjusted income, we assumed 3% inflation, which has been the average over the last century. The nominal median average income increases at an average rate of approximately 0.5% per year, so it fails to keep pace with an assumed 3% inflation. At age 90, the nominal income would need to be in the 15th percentile of outcomes to keep pace with 3% inflation.

Any sales claim that the VA+GMWB income will keep pace with inflation should be viewed with extreme skepticism. Moreover, its performance will exhibit an undesirable positive correlation to the equity and fixed-income markets; in those cases where the income fails to ratchet up, the investor’s other assets are likely to fare poorly.

Combining the data from the prior two figures, one can determine the cost and benefit of the VA+GMWB based on life expectancy. Until age 73, there is a near-100% chance that the passive portfolio will survive, and the VA+GMWB provides virtually no value.

At age 82, which is the life expectancy for a 60-year old male, the probability of the passive portfolio surviving is 90.42%. If it fails to survive, the median value for the VA+GMWB is $55,208 in average nominal income ($28,719 after adjusting for inflation – equivalent to 63.8% of the purchasing power of the initial $45,000 income).

The probability of the passive portfolio surviving drops to 80% at age 88, at which point the median VA+GMWB average nominal income is $55,701 ($24,346 on an inflation-adjusted basis). The probability drops to 70% at age 95, at which point the median VA+GMWB average income is $55,497 of nominal income and $19,723 of inflation-adjusted income.

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At age 113, which is where our mortality table ends, there is still a 21% chance the nominal income would never increase above its initial value of $45,000.

Although accurately computing the cost and benefit of the longevity insurance requires a consideration of life expectancy, the probability the passive account will be depleted, and the likely income the VA+GMWB will provide, one can obtain a high-level estimate. Overall, the passive account has a 9.83% probability of being depleted, but the median average total cash flow for the passive strategy exceeds that of the VA+GWMB strategy by $862,942.

We also computed those values for a hypothetical scenario in which the VA+GMWB payout never increased above its initial value of 4.5%. Our intent here was to show the additional cost and benefit the VA+GMWB offers through the feature of its increased payout amount based on market performance. In this case, the passive account has a 7.22% chance of being depleted and it has a median average of $1,169,050 in additional total cash flow. Thus, by adding the increased payout feature of the VA+GMWB, the investor makes a tradeoff: the chance that the passive portfolio will be depleted increases by 2.61%, but the median total cash flow also increases by $306,108.

Ultimately, the VA+GMWB is handicapped by its fee structure. As Joe Tomlinson, an advisor based in Maine who has studied this product and reviewed this article, put it, “With fees in excess of 3% of assets, most of the equity risk premium is gone, leaving the investor with stock-like volatility and bond-like returns.”

Three other observations

We considered three other factors, each of which a potential VA+GMWB investor should consider: how the VA+GMWB compares to a SPIA, the size of a potential bequest the VA+GMWB might provide, and whether it is advantageous to purchase it prior to age 60.

Anyone considering the purchase of an annuity should compare its costs and benefits to the most basic annuity offering – the SPIA. A 60-year old male in Massachusetts can purchase an SPIA with a nominal payment of 6.84%. Neither the median average nor the terminal income from the VA+GMWB account reach this level, as can be seen from figures 3a and 3b.

Figure 4 shows the probability of the ending income from the VA+GMWB surpassing the SPIA based on life span.
Thus, for someone whose goal is solely to maximize his or her lifetime income, the SPIA is superior to the VA+GMWB.

Incidentally, the SPIA has a lower IRR (2.60%) than the VA+GMWB (4.08%), when measured in a mortality-based framework as in figure 1. With the SPIA, however, all the cash flow goes to the annuitant. The VA+GMWB has a death benefit, so a good portion of its return goes to the annuitant’s heirs, not the annuitant.

The comparison between the SPIA and the VA+GMWB, while informative, is imperfect. The SPIA is a pure annuity; it cannot be terminated, and it does not pay a death benefit. The VA+GMWB can be terminated (in some cases – although not with Nationwide’s – with a penalty) and it pays a death benefit.

Since the VA+GMWB pays a death benefit equal to the remaining contract value, we can also look at the estimated bequest it offers:
These are nominal values, not adjusted for inflation. Notably, the median ending contract value for the VA+GMWB is zero after age 88.

We calculated the present value of the bequest shown in figure 5, after adjusting for mortality. We chose a discount rate of 3%, reflecting a premium over of the risk-free rate to allow for Nationwide’s creditworthiness, and the present value was $519,984. Investors should carefully consider the fact that roughly half of their investment in a VA+GMWB is likely to be passed on to their heirs and, moreover, weigh the tax consequences of that decision against other ways that money could be gifted.

Nationwide’s product has two variations. One can invest at age 55 and receive an initial payout of 5% (instead of 4.5%) beginning at age 60, or one can invest at age 50 and receive a beginning payout of 5.5% at age 60. These two options offer superior returns to investing at age 60:

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<tr>
<th>Age at Investment</th>
<th>Beginning Payout %</th>
<th>IRR</th>
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<tbody>
<tr>
<td>50</td>
<td>5.5%</td>
<td>4.55%</td>
</tr>
<tr>
<td>55</td>
<td>5.0%</td>
<td>4.33%</td>
</tr>
<tr>
<td>60</td>
<td>4.5%</td>
<td>4.08%</td>
</tr>
</tbody>
</table>

These IRRs are a first approximation of the relative merits of these investments, and they indicate that investing earlier provides better longevity insurance at a lower cost, as compared to investing at age 60; a full analysis would require replicating the figures above. The passive portfolio will have the same return characteristics regardless of whether the investment begins at age 50, 55 or 60.
The broader lessons

We are not the first to examine Chen’s research. Bob Veres criticized Chen in a 2008 article that appeared in *Financial Planning*. Veres rightly pointed to the tax inefficiencies of the VA+GMWB as compared to the passive portfolio and to its lack of inflation protection.

He also questioned whether industry-funded research, such as Chen’s, can be objective. That point bears reinforcement.

The movie *Inside Job* offers a disturbing case study of industry-funded research gone awry. Frederick Mishkin, a former Federal Reserve Governor, was paid $124,000 by Iceland’s Chamber of Commerce to study the stability of Iceland’s banking system in May of 2006, prior to the financial crisis. “The economy has already adjusted to financial liberalization,” Mishkin concluded, “which was already completed a long time ago, while prudential regulation and supervision is generally quite strong.”

Iceland’s economy collapsed less than two years after Mishkin’s report, due in large part to lax regulation and insufficient supervision.

It is inconceivable that industry-funded research would ever be published if it failed to support the thesis of its sponsor. This study and Veres’ article are examples of the level of scrutiny that should be applied to such research before relying on any of its findings.

Even if one were to pay no heed to industry-funded research, the complexity of the VA+GMWB should be sufficient to raise significant concerns. I needed the help of a trained mathematician and economist and the construction of a Monte Carlo model to accurately and comprehensively understand the product. Who can an advisor, much less an unsophisticated investor, turn to for similar support?

The British economist John Kay has been critical of overly complex financial products. He wrote about the dangers posed by “kickout bonds,” but he could have just as easily been writing about the VA+GMWB. “The idea that small savers are equipped to assess the risk associated with these products by reading the small print is absurd,” he said, “as absurd as the notion that consumers can protect their families through do-it-yourself toxicology assessments of the food they buy.”

As I noted at the outset, the VA+GMWB is not a bad product, in that it offers a 4.08% median IRR, which will compare favorably to many, perhaps most, other annuities. But it is very complex, and I am sure this article will not be the last word on its merits. The decision to buy an annuity, like any other investment product, comes down to relative risk and the cost of mitigating that risk. This analysis should demonstrate that risk can’t be boiled down to standard deviation or to the contrived measures that Chen employed.
As Michael Edesess told me, “In a sense, all risk is longevity risk – the risk that you'll run out of money before you finish your spending program. The probability of that event occurring may be the best measure of risk, which needs to be compared with the expected cost.” Our study can make that comparison. Chen’s can’t.

Appendix – A description of the VA+GMWB

The guaranteed minimum wealth benefit (GMWB) is a rider applied to a variable annuity (VA). Our model operated as follows:

- The purchaser invests a fixed amount ($1,000,000 at age 60, in our example) and receives a payout percentage (e.g., 4.5%).
- The funds are invested in VA sub-accounts with a 70% equity/30% fixed income allocation.
- The account balance and contract base are initially set to $1,000,000
- At the end of each year
  - The income amount is determined by multiplying the contract base by the payout percentage
  - The account balance is reduced by the income amount and by the fees. The fees are 2.4% applied to the account balance and 0.6% applied to the contract base.
  - The account balance is adjusted up or down based on the performance of the sub-accounts. The account balance cannot be less than zero.
  - If the resulting account balance is greater than the contract base, the contract base is reset to the account balance
- The investment is terminated by the death of the investor or if it is canceled by the investor. In this case, the investor (or his or her heirs) is paid the remaining account balance.

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