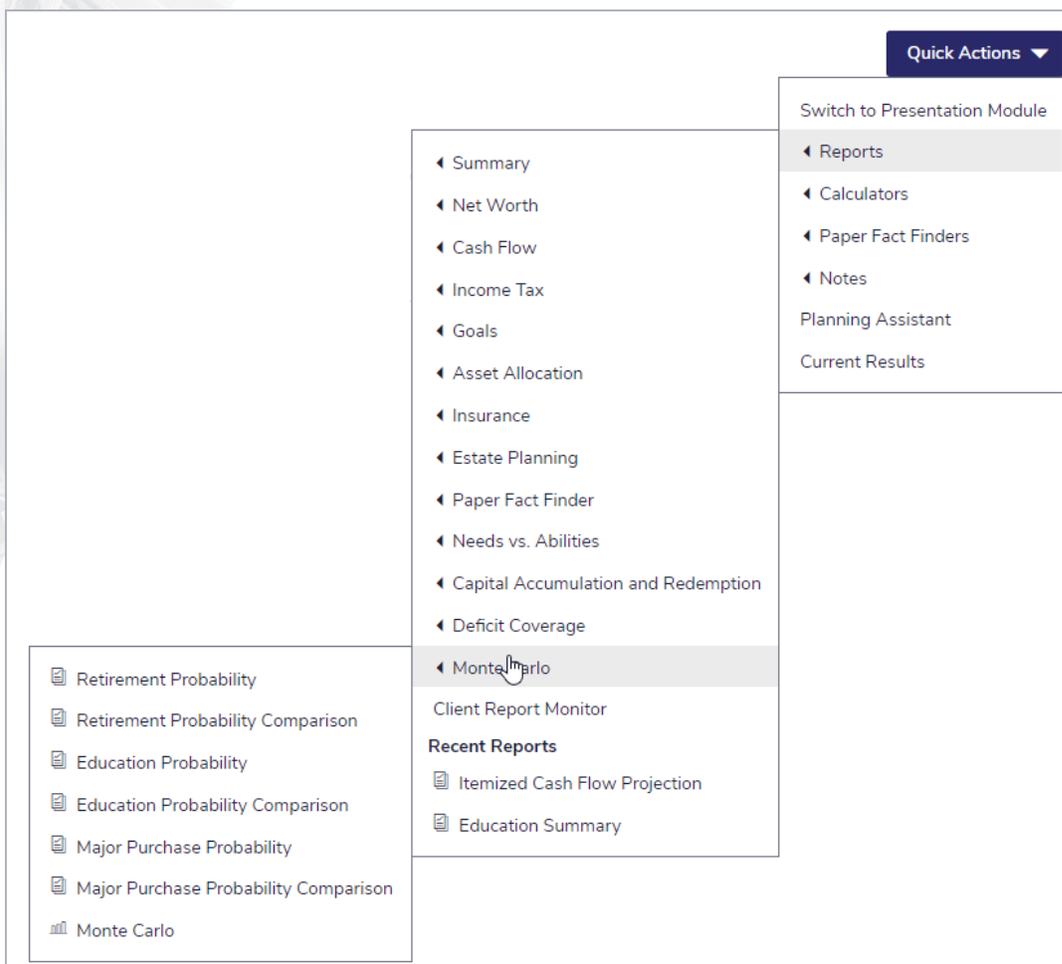


Monte Carlo Analysis

Functions Addressed in this Document:

- How does Monte Carlo work in NaviPlan?
- How do you interpret the **Monte Carlo Analysis** report results?



Quick Actions – Reports – Monte Carlo

The **Monte Carlo Analysis** is a simulation tool you can use to determine the effect of market and longevity risks on a completed plan. In order to perform a Monte Carlo analysis, the **Monte Carlo Analysis** module must be selected on the **Plan Management – Modules – Modules**.

While this document was created using the Morningstar Asset Allocation option; however, the **Monte Carlo Analysis** module is also available if a user-defined asset allocation option is used. This document has been created using a **Level 2 Plan** with the **Average Tax** income tax method selected (accessible from **Settings - Plan Settings – General**).

How does Monte Carlo work in NaviPlan?

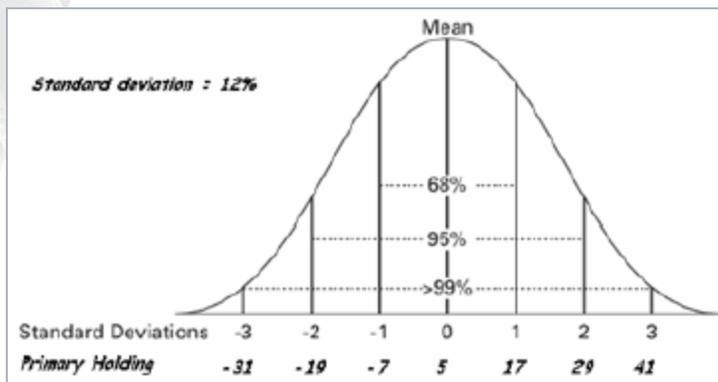
Traditionally, a deterministic financial planning approach analyzes only one possible outcome. This outcome assumes that assets will always earn their expected rates of return. Realistically, while return rates may average out in the long run, they can vary significantly from year to year.

The Monte Carlo simulation generates multiple projections. Prior to performing these projections, NaviPlan® converts the geometric return rates assigned to the clients' investment assets to the equivalent arithmetic mean to obtain a normal distribution whose geometric mean is the original annualized rate of return.

Within each projection, NaviPlan randomizes the return rates annually using each investment asset's standard deviation to present a range of possible outcomes for the growth of the clients' portfolios. Based on each projection, NaviPlan's Monte Carlo analysis uses the clients' cash flow to determine the success rate displayed.

DID YOU KNOW? If Monte Carlo analysis's random fluctuation results in a negative rate of return, only accounts with deferred growth will use that negative rate. Assets with no deferred growth value will use 0% instead of the negative return rate.

The **Monte Carlo Analysis** uses standard deviation as a statistical measure of the range of each investment asset's performance volatility. The higher an asset's standard deviation, the more volatile its returns are likely to be. Standard deviations are associated with both asset classes and individual investment assets.



Example 1: For the sample asset, the mean is assumed to be the actual return rate that was entered for the asset (in this case, 5%). Monte Carlo will randomize return rates based on a normal distribution (along a standard bell curve). In the example to the left, we can see that if the standard deviation is 12% and the return on the asset is 5%, then 68% of the iterations will typically produce a return between -7% and 17%, or within 1 standard deviation of the mean.

DID YOU KNOW? When generating the **Monte Carlo Analysis**, iterations are not restricted to a number of standard deviations from the mean. Instead, NaviPlan® restricts the return rate from -100% to 100% plus two times the mean. Using the example above, in which the asset has a 5% return, the return would be limited to -100% and 110%.

Assign Settings
ⓘ ×

Scenario: Current ▾

Insurance Scenario: ▾

Solve Retirement Goal

Randomize Life Expectancy

Force Full Deficit Coverage

Show Goal Details Graphs in Report

Retirement Goal Deficit Tolerance: -10,000

Education Goal Deficit Tolerance: -500

Major Purchase Goal Deficit Tolerance: -500

Number of Projections: 500

OK
Cancel

In the **Assign Settings** box, the **Randomize Life Expectancy** option is cleared by default. If the default is used, the client's and co-client's life expectancies are based on the values entered under **Life Expectancy** in the **Plan Management** section – **Assumptions** category – **Milestones** page. If **Randomize Life Expectancy** is selected, longevity risk is evaluated. The client's and co-client's life expectancies will be randomized up to a maximum life expectancy of 110 years, based on of the IAM71 actuarial table used by insurance companies to predict life expectancy.

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Force Full Deficit Coverage is also cleared by default. If the default is used, assets available for the retirement goal will only be redeemed in the **Monte Carlo** analysis during the retirement period. If **Force Full Deficit Coverage** is selected, the analysis automatically redeems available assets throughout both the pre-retirement and retirement periods to cover annual cash to cover annual cash flow deficits. Any non-registered investment assets (including assets linked to the retirement goal and unlinked assets) owned by the client or co-client are used to cover deficits in a tax-efficient manner. Registered assets are not available until the owner retires. Selecting **Force Full Deficit Coverage** only affects the retirement goal. Any non-registered assets owned by the clients that are linked to other goals, such as education and major purchase, will become available once the goal to which the asset is linked is achieved.

Ideally, the plan for which the Monte Carlo simulation is generated should already have a positive cash flow with no cash flow deficits in pre-retirement. Realistically, if pre-retirement cash flow deficits actually occurred, the clients would need to cover them. Selecting **Force Full Deficit Coverage** simulates this situation, with the redemption of assets to cover cash flow deficits. Although this is a more conservative approach, selecting **Force Full Deficit Coverage** may cause the depletion of assets that would normally be used to fund the retirement goal, which may result in a higher incidence of failures in the **Monte Carlo** simulation. Clearing **Force Full Deficit Coverage** assumes that the clients will never redeem assets to cover pre-retirement cash flow deficits.

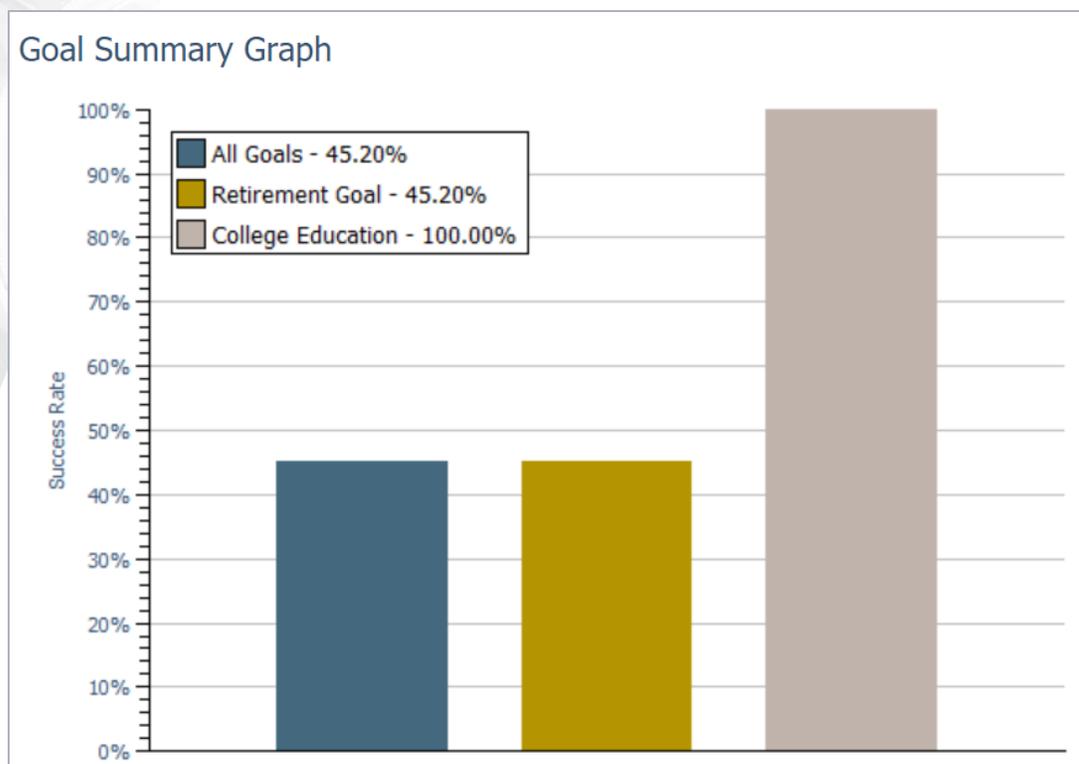
The success rate displayed is measured based on trials that do not exceed established accumulated cash flow deficit tolerance levels. After determining what deficits or shortfalls your clients are comfortable with, while still considering each goal a success, you can define the cash flow deficit tolerance levels for each goal.

It is often useful to define a different cash flow deficit tolerance for each goal, because while a \$5,000 cash flow deficit may not be significant for a retirement goal that bs many years, for a three-year education goal this amount may be too significant to absorb. In the latter case, the cash flow deficit tolerance for the education goal could be set to a lower amount.

DID YOU KNOW? The minimum number of projections that can be entered under **Assign Settings** is 100 and the maximum number is 1,000. As the number of projections increases, the more statistically significant the results will be; however, the time required to perform the calculations also increases. In client reports, Monte Carlo results are based on 500 trials.

How do you interpret the Monte Carlo Analysis report results?

The first two tables that appear in the **Monte Carlo Analysis** report are **Assumptions** and **Asset Standard Deviations**. The information in the Assumptions table is based on what was specified under **Assign Settings**. The information contained in the **Asset Standard Deviations** table was entered on the **Enter Financial Data – Net Worth – Accounts – Details – Return Rates**.



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The **Goal Summary Graph** illustrates the success rate for each of the clients' goals based on the assumptions set under Assign Settings.

For the retirement goal, each projection only examines the retirement years for success or failure. All cash flow sources in each year of the retirement goal are taken into account, and accumulated cash flow deficits are compared to the retirement goal cash flow deficit tolerance to determine whether a projection succeeds or fails.

For education goals, the results for each goal defined in the plan are isolated, and only the years during which the education expenses apply are examined for success or failure. Only cash flow pertaining to education expenses and education goal funding accounts are used to determine if there are cash flow deficits during the education goal analysis period. Year-by-year education cash flow is examined instead of the accumulated cash flow.

Example 2: In this case, the annual education goal cash flow deficit tolerance is (\$500) (under **Assign Settings**). The total cash flow deficit for each goal is shown below (\$750) as calculated in the **Monte Carlo Analysis**. The education goal is a success because the cash flow deficit education goal never exceeds the cash flow deficit tolerance of (\$500).

Goal	Cash Flow Total			
	Year 1	Year 2	Year 3	Year 4
Education Goal	(\$250)	(\$250)	(\$250)	\$0

For major purchase goals, the results for each goal in the plan are isolated, and only the year in which the expense applies is examined for success or failure. Only the major purchase expense and any major purchase funding account redemptions in the purchase year are examined to determine if there is a cash flow deficit greater than the deficit tolerance defined for major purchase goals. For each goal type (i.e., retirement, education, and major purchase), NaviPlan[®] considers the tax consequences of the funding account redemptions when examining the success or failure.

The success rate for **All Goals** in the **Goal Success Rates** table (shown in more detail below) is assessed differently. If all the goals succeeded in a projection, the entire projection is considered a success. If just one goal did not succeed in a projection, then the entire projection is considered a failure.

Example 3: Using a simplified example with three projections, we see in the table directly below that all goals succeeded in only one projection (i.e., cash flow deficit tolerance was not exceeded); the success rate for all goals is therefore 33%.

Projection	Retirement Goal	Education Goal	All Goals
#1	Success	Success	Success
#2	Success	Failure	Failure
#3	Success	Failure	Failure

The **Goal Success Rates** table follows, which displays the success rate of all projections for each goal in percentiles. The **Success Rate** column displays the percentage of successful projections shown in the **Goal Summary Graph**.

Goal	Success Rate	90th Percentile	50th Percentile	10th Percentile
All Goals	45.20%			
Retirement Goal	45.20%	\$6,378,017	\$42,840	\$36,176
College Education	100.00%	\$70,966	\$66,900	\$63,315

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The percentile amounts for the education goal are the total after-tax asset values accumulated as of December 31 of the year prior to the last year of the goal. This amount includes any excess funding account residuals that exist at the end of the goal.

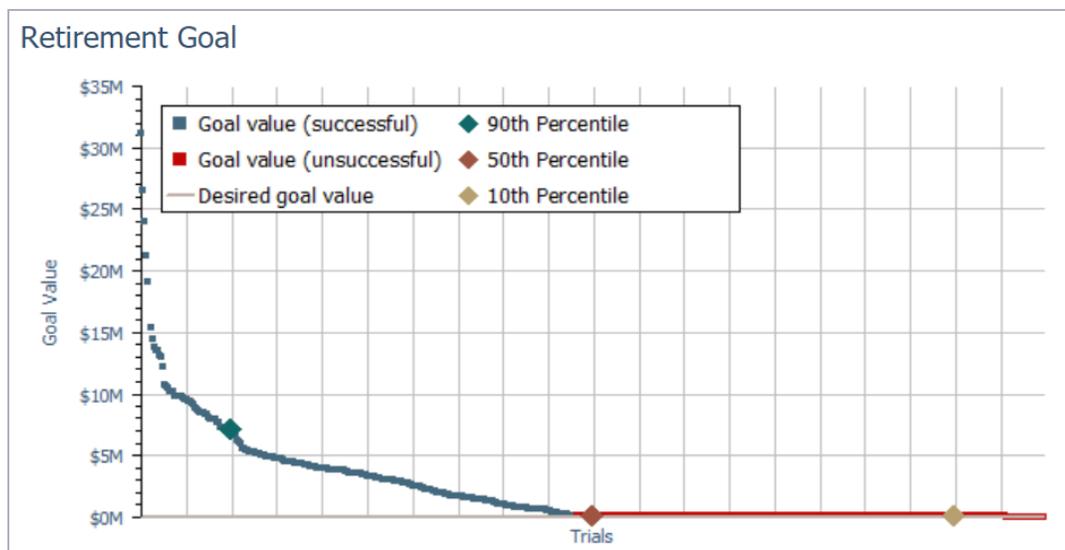
- The **10th percentile** column shows that 10% of the results are lower than this amount; 90% of the results are higher.
- The **50th percentile** column shows that 50% of the results are lower than this amount; 50% of the results are higher.
- The **90th percentile** column shows that 90% of the results are lower than this amount; 10% of the results are higher.

If **Show Goal Details Graphs in Report** is selected under **Assign Settings** before generating the **Monte Carlo Sensitivity Analysis**, individual goal graphs will appear. From the **Goal Success Rates** table, the dollar values for the 10th, 50th, and 90th percentiles are plotted on the individual goal graphs for retirement, education, and major purchase goals.

Example 4: Looking at the **Goal Success Rates** table and the individual goal graph for the retirement goal, we can see how the percentiles and their corresponding dollar amounts are calculated. Each of the trials is plotted on the **Retirement Goal** graph. In the table, the column for the **10th Percentile** shows (\$36,176), which we see plotted with a beige diamond in the **Retirement Goal** graph.

Goal	Success Rate	90th Percentile	50th Percentile	10th Percentile
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Retirement Goal	45.20%	\$6,378,017	\$42,840	\$36,176
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This means that 10% of the time, the clients' terminal net worth will be less than (\$3,236,941), 50% of the time less than \$266,234, and 90% of the time less than \$82,004,007.

For each goal, the goal value related to each projection is plotted on the graph. Each gold or blue square represents the goal value for a projection run in the analysis. For example, if 100 projections are run, you will see 100 squares plotted on the graph. A blue square represents a successful projection and a gold square represents a failed projection. All projections are plotted from the highest goal value starting at the left to the lowest goal value at the right.

DID YOU KNOW? For the retirement goal, failures can still occur when a clients' terminal or ending net worth is positive. This is a concept that is often misunderstood by users who have previously used a Monte Carlo Analysis based solely on net worth. Without liquid assets available to cover cash flow deficits, a plan can have an unfunded deficit in excess of the cash flow deficit tolerance and, therefore, a failure will be reported.

DID YOU KNOW? For major purchase or education goals, the **Desired goal value** line on the graph reflects the sum of the total expenses. However, for the retirement goal, because the goal is to cover all expenses during retirement with no cash flow deficits and no residual assets, the **Desired goal value** line is zero. This represents a balanced cash flow situation in which the clients would have no cash flow surpluses or deficits.