# Efficient Frontier

## **Definition:**

**The Efficient Frontier graphically displays the relationship between potential risk and potential returns for a different portfolio of investment.**

* **What it is**: Efficient Frontiers were developed in 1952 as a way of measuring different portfolios to determine which portfolio would provide the highest returns at a given level of risk (as measured by the standard deviation of the portfolio). The Efficient Frontier can also be used to determine which projects in a business portfolio, or strategic alternatives, are best at providing efficient returns or "Bang for the Buck" (the biggest return for the given investment or cost). It can do the same for a variety of projects or alternative strategy approaches for a company. Investopedia describes the investment portfolio analysis use of the graph as follows: The efficient frontier is the set of optimal portfolios that offers the highest expected return for a defined level of risk or the lowest risk for a given level of expected return. Portfolios that lie below the efficient frontier are sub-optimal because they do not provide enough return for the level of risk. Portfolios that cluster to the right of the efficient frontier are also sub-optimal because they have a higher level of risk for the defined rate of return.
* ​**What does it do**: It shows the balance between risk and reward and how the tradeoffs are different from portfolio to portfolio. It can also indicate the different forecasted project returns (or strategy alternative option returns) compared to the required up from investment required or total costs required.

## **Uses:**

The two main uses are 1. To determine which portfolios an investor should pursue based upon their relative acceptance or aversion to risk and 2. To determine which projects or strategies will provide the largest returns compared to the amount of money that will need to be invested or spent to implement the project or strategy option.

* **How is it used**: The three primary uses of the Efficient Frontier are for analysis of Investments, Projects, and Strategy Options.
	+ Investment Portfolio Analysis: Investors will compare various portfolios and individual assets/securities to determine the highest return investment at their designated acceptable level of risk
	+ Project Analysis: Business Managers will compare various Projects to determine the highest return forecasted for each project and the required investments and or costs associated with implementing the project. The Efficient Frontier graph has the capital/cost element on the X-axis and the forecasted return on the Y-axis and the projects plotted on the graph. The Business Manager is often looking for the project with the Biggest "Bang for the Buck" which is defined by the slope of the line between projects. How much do you have to invest to get the next dollar of return? If Project B returns $3 for every $1 more invested than Project A it is said to have a $3 Bang for the Buck. You want the project with the largest Bang for the Buck possible.
	+ Strategic Options Analysis: Business Leaders faced with multiple options want to receive the greatest return possible for the investment/cost required to implement each strategic option. The analysis of different strategy options is analyzed in the same ways as the project analysis in the example above.
* ​**Where**: The Efficient Frontier graph has increasing returns measured on the Y-axis and increasing risks or costs on the X-axis. Therefore the upper left-hand corner of the graph is the most efficient point on the graph because it has infinite returns at little or no risk or investment. Therefore the investment, project, or strategy option closest to the upper left-hand corner will be on the efficient frontier curve.
* **Why**: Efficient frontier graphs are designed to find a balance between returns and risk and to finds the biggest "Bang for the Buck" alternative projects and strategy options.

## **Limitations:**

* **Where it shouldn't be used**: There is not any situation that excludes efficient frontier analysis except where only one option is being considered. Tools such as NPV and IRR are better suited for single option decisions.
* **Any restrictions**: No restrictions, but there are warnings (see below)
* **Warnings**: There are a number of assumptions made by Markowitz in his initial definition of Efficient Frontiers to measure portfolios (see: [2975974](https://www.jstor.org/stable/2975974).) Many times portfolio risk does not follow a normal curve distribution and the returns can have greater deviations than the assumed 3 deviations by Markowitz. Therefore the investor needs to carefully consider the investment portfolio performance and risk in the assignments to the graph.

## **Demonstrations:**

* [The efficient frontier](https://www.youtube.com/watch?v=vnAbsNN3SbA)
* YouTube Video finding Efficient Frontier for 2 stocks: [Graphing the efficient frontier for a two-stock portfolio in Excel](https://www.youtube.com/watch?v=VsQZEgyTKeA)

## **Step-by-step process:**

**For the investment, portfolio analysis** use the step by step process from Economist at Large and their template in the section below: http://economistatlarge.com/portfolio-theory/efficient-frontier

**For an Efficient Frontier for Projects and Strategy Options Step by Step Process see the outline below:**

* **Gathering data**:
	+ Identify the Projects or strategy options that you wish to graph
	+ Place the forecasted returns for each project or option in a spreadsheet
	+ Place the corresponding capital investment or total costs for each project or option in the spreadsheet
	+ Build an X/Y scatter plot graph with returns on the Y-axis and costs on the X-axis (with increasing amounts on each axis)
	+ Draw a line through the projects or options that are closest to the upper left-hand corner. That is your efficient frontier
* **Analysis of data**:
	+ Try to identify hybrid projects or options that could replace your existing projects and options and plot the hybrids on the graph
	+ You can even create additional hybrids by combining existing projects and options or even two of the hybrid options to make double hybrids
	+ You try and create hybrids that will fall outside the efficient frontiers and even closer to the upper left-hand corner than the line
* **Interpretation of results**:
	+ If you have limited funds to pay for all of the projects, or can only implement one strategy option you want to identify the best one or ones.
	+ Those projects which lie on or above the efficient frontier are the best options
	+ If 2 projects or options lie equally close to the efficient frontier you want to select the one that has the biggest total earnings or the biggest "Bang for the Buck" (highest % return per $ of investment)
* **Presentation of results**:
	+ Plot the project options on the efficient frontier
	+ Show where the hybrids and double hybrids came from and add them to the graph
	+ Highlight the option or projects that are closest to the upper left corner that is being recommended.

## **Template for capturing data:**

* For Investment Portfolio Analysis: This online tool calculates and plots the efficient frontier for the specified asset classes, mutual funds, ETFs, or stocks for the specified time period. <https://www.portfoliovisualizer.com/efficient-frontier>
* Economist at Large Template:
* Template for Projects and Strategy Options:

## **Output representation and recommendations:**

**Investment Efficient Frontier examples from Wikipedia and Economist at Large**

**Wikipedia**

**Efficient Frontier for Projects or Strategy Options**

                                          **Economist at Large**

## **Examples:**

* Example Efficient Frontier for Projects and Strategy Options:

## **Additional resources:**

* [Efficient Frontiers for Portfolios](http://moneychimp.com/articles/risk/efficient_frontier.htm)
* [Portfolio Analysis from Investopedia with Efficient Frontiers](http://www.investopedia.com/terms/e/efficientfrontier.asp)
* [Comparing Projects or alternative Strategy Approaches in an Efficient Frontier](https://support.office.com/en-us/article/Use-the-efficient-frontier-chart-b291739e-5c20-4538-9706-0969b951c154)

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