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Portfolio Analytics

Dr. Wolfgang Marty/St. Petersburg/ 04.12.2014

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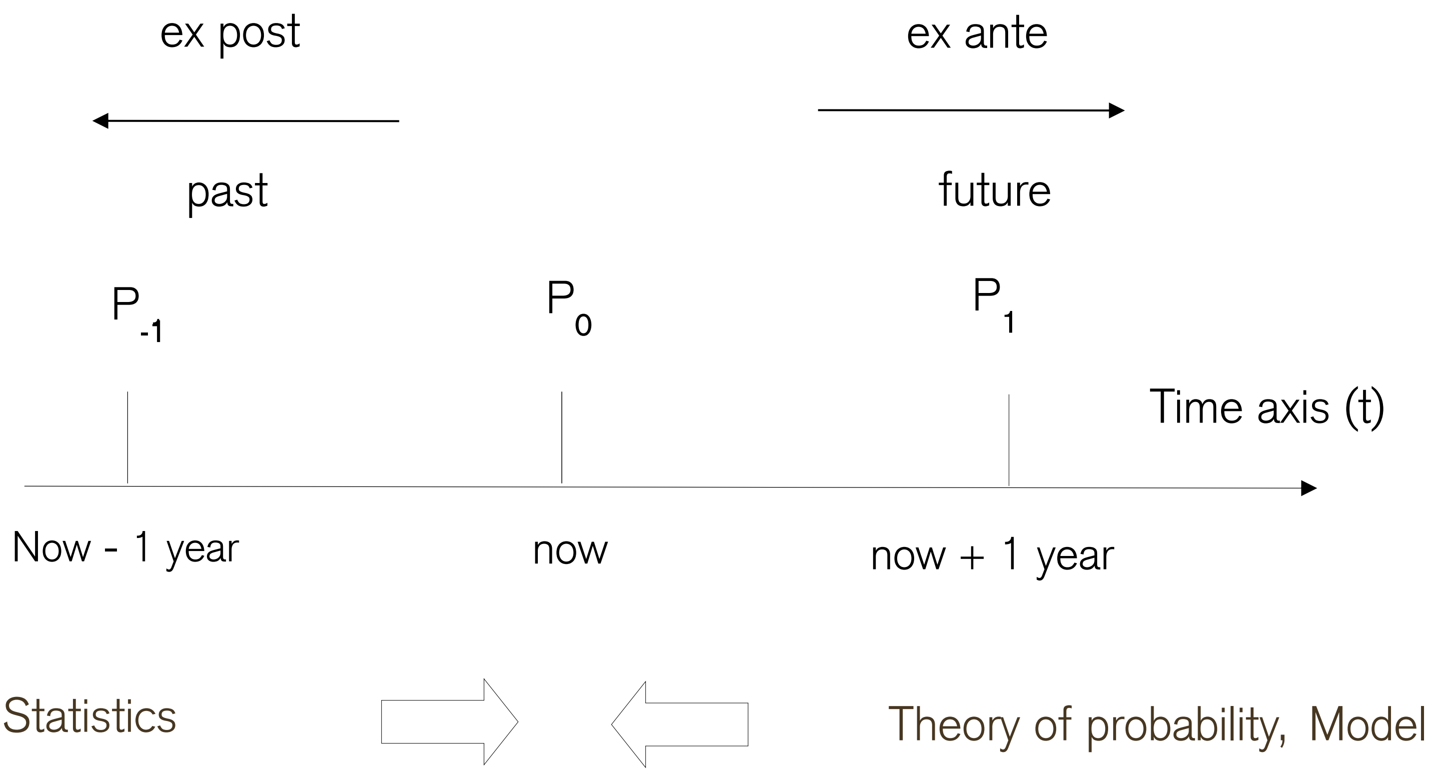
1. The Performance of a Portfolio

Introduction

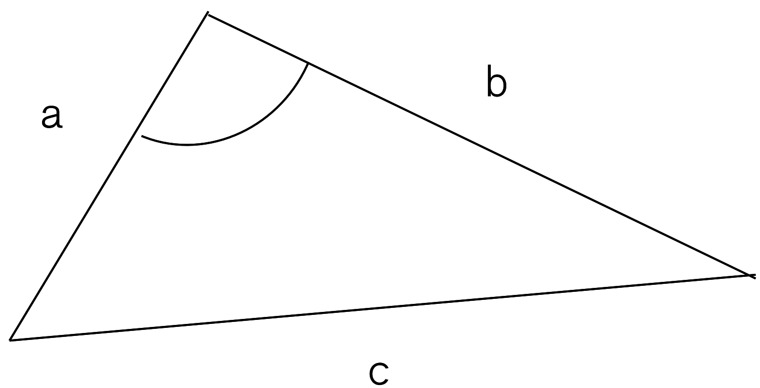


A definition

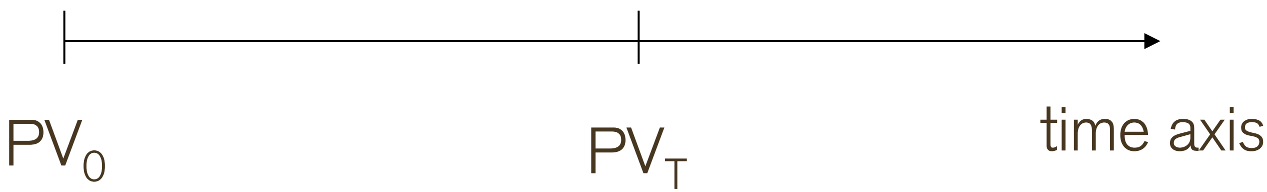
Portfolio Analytics is concerned with quantifying the sources of the return and assessing the risk of a portfolio. It does not only measure the evolution of the wealth over a certain time period but also provides a comprehensive discussion of the performance of specific portfolios.

Performance

- The ***return*** is linear, i.e., the return of a portfolio is equal to the sum of the weighted returns of its investments
- ***Risk*** obeys a generalization of the theorem of the Pythagorean Theorem



The definition of the return



$$r = \frac{PV_T - PV_0}{PV_0}\ , \ PV_0 > 0,\ PV_T \geq 0.$$

- We assess the return over a time span (**first concept**) .
- We divide the profit or loss by the invested capital.
- We assume that there is no cash flow between PV_0 and PV_T.

No cash flow

- This ratio is invariant by scalar $\lambda \in \mathbf{R}^1$

$$r = \frac{PV_T - PV_0}{PV_0} = \frac{\lambda \cdot PV_T - \lambda \cdot PV_0}{\lambda \cdot PV_0} \text{ , i.e., } \lambda = \frac{1}{PV_0} \Longrightarrow r = \frac{PV_T}{PV_0} - 1$$

- The portfolio manager is measured by percentages, i.e., the return does not dependent on the absolute size of portfolio.

$\Longrightarrow$ Fundamental characteristics of the Time - weighted rate of return (TWR)

The Benchmark

- **Pro memory:** A reference portfolio is called a ***benchmark portfolio*** or simply a ***benchmark***.
- We distinguish between an **industry-standard** benchmark and **tailor-made** benchmark.
- **Industry-standard Benchmarks** are provided and published by big institutions, like MSCI, Barclays and J.P. Morgan. As they are used by many portfolio manager and they enabled an peer analysis.

The Benchmark

- In Switzerland we have the SBI and the LSI for fixed income portfolio. The following Russian Bonds are in the SBI

CH0123431709	500000000	Vnesheconom Bank	3.75 % Anleihe 2011 - 2016
CH0193724280	600000000	JSC VTB Bank	3.15 % Anleihe 2012 - 2016
CH0205819433	250000000	Russian Railways	2.177 % Anleihe 2013 - 2018
CH0205819441	525000000	Russian Railways	2.73 % Anleihe 2013 - 2021
CH0204477274	150000000	Sberbank of Russia	2.065 % Anleihe 2013 - 2017
CH0226274261	500000000	Open JS Company Gazprom	2.85 % Anleihe 2013 - 2019
CH0226747746	300000000	JSC VTB Bank	2.90 % Anleihe 2013 - 2018

Taylor-made Benchmarks are used for balanced portfolio and for exclusion or inclusion of specific markets in the benchmark

The Benchmark

$$r_P = \sum_{j=1}^{n} w_j r_j = w_1 r_1 + \ldots\ldots + w_n r_n \qquad (r_P\text{: portfolio return})$$

$$r_B = \sum_{j=1}^{n} b_j r_j = b_1 r_1 + \ldots\ldots + b_n r_n \qquad (r_B\text{: benchmark return })$$

(w_j ,b_j : weights, r_j: return of a single security)

In the following we show an example of a typical tailor made benchmark

A decomposition of the relative return

Stock	Return	Portfolio	Benchmark	Values added	Over and under weight	BHB*	BF*
A	-20.00%	15.00%	25.00%	-17.50%	-10.00%	2.00%	1.75%
B	30.00%	25.00%	25.00%	32.50%	0.00%	0.00%	0.00%
C	-10.00%	60.00%	50.00%	-7.50%	10.00%	-1.00%	-0.75%
Return		**-1.50%**	**-2.50%**			**1.00%**	**1.00%**

*BHB: Brinson-Hood-Beebower
*BF: Brinson-Fachler

The decomposition of Brinson-Hood-Beebower (BHB)

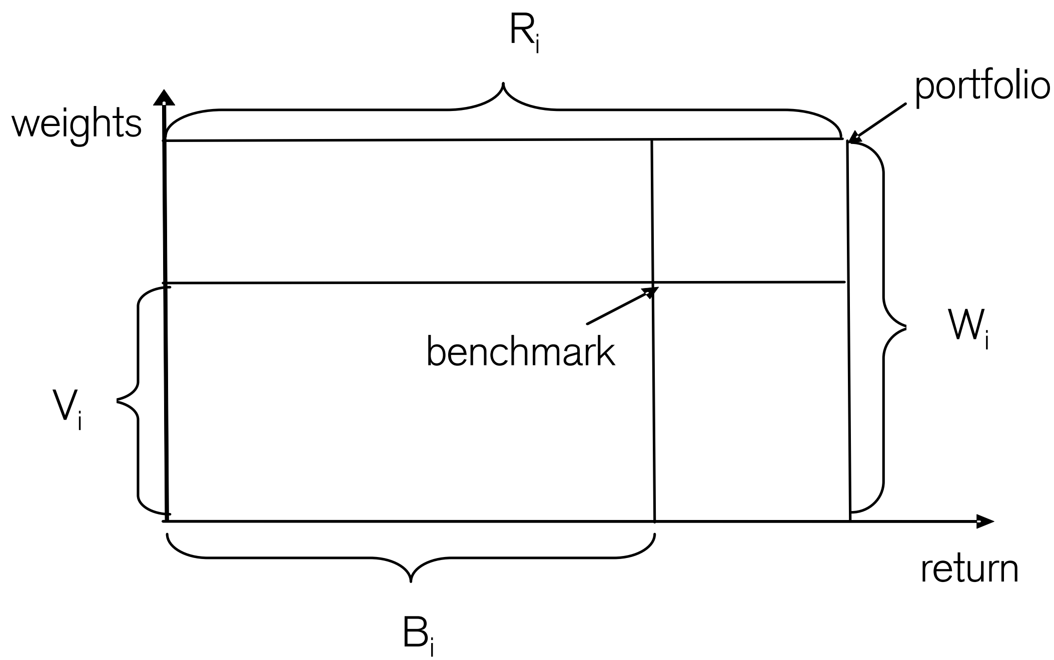
- ***Return attribution*** is the decision-oriented decomposition of the return.

- A ***segment*** is a set of investments in the investment universe.

- We have a mathematical identity on segment level:

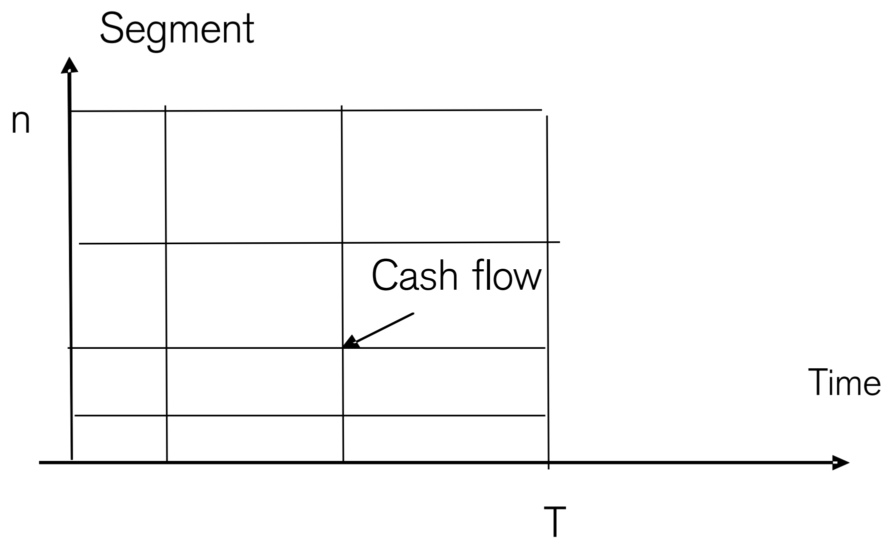
$$W \cdot R - V \cdot B = \underbrace{(W - V) \cdot B}_{\text{Asset Allocation}} + \underbrace{(R - B) \cdot V}_{\text{Stock Picking}} + \underbrace{(W - V) \cdot (R - B)}_{\text{Interaction}}$$

The decomposition of Brinson-Hood-Beebower (BHB)



- Segment level
- Interaction effect

The portfolio return problem



- Interaction effect (horizontally) and compounding effects (vertically)
- Horizontally and vertically do in general not add up

Properties of the Time weighted return

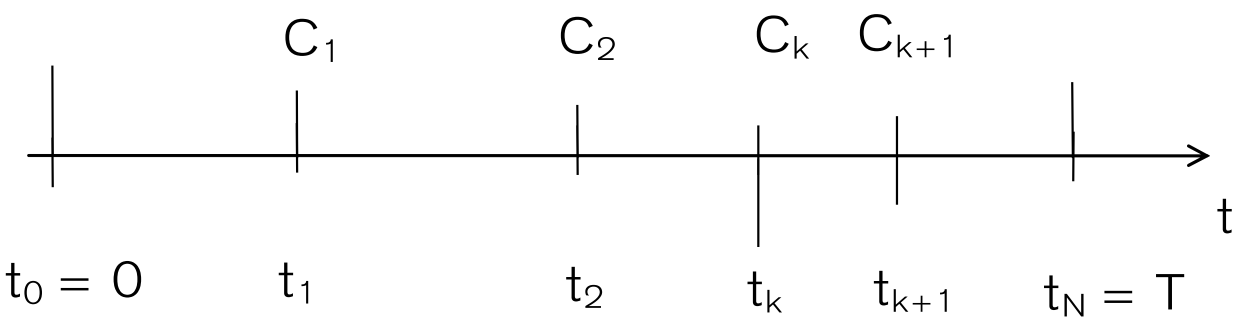
- Time-weighted rate of return (TWR) measures the return of a portfolio in a way that the return is ***insensitive*** to changes in the money invested.

- TWR measures the return from a portfolio manager's perspective if he does not have control over the (external) cash flows

- TWR allows a comparison against a benchmark and across peer groups

- calculating, decomposing and reporting TWRs is common practice

The internal rate of return (IRR)



$$PV_0 = \sum_{k=1}^{N-1} \frac{C_k}{(1+r)^{t_k}} + \frac{PV_T}{(1+r)^{t_N}}$$

where PB_0, PE_T, respectively are the beginning and ending values of the portfolio, respectively and C_k are the cash flows at time t_k, $k = 0, 1, 2, \ldots, N$ with $t_0 = 0$, t_N.

The internal rate of return (IRR)

The fundamental properties are:

- IRR is based on the condition that the value today is equal to the discounted cash flow in the future (No arbitrage condition) **(Second principle)**.
- The investment assumption is that the cash flows are reinvested by the internal return

Different approximation schemes (IRR)

- is an arbitrage relationship
- is a type of Money-weighted rate of return (MWR)
- takes all knots simultaneously into account
- cash flows are reflected
- has in general multiple solutions
- is a transcendental equation, i.e., the solution uses numerically analysis

Different approximation schemes (IRR)

$$1.\ r_{nom} = w_1 r_1 + w_2 r_2 + \ldots.. + w_n r_n \qquad w_j = \frac{N_j}{\sum_{i=1}^{n} N_i},\ 1 \le j \le n$$

$$2.\ r_{lin} = \widehat{w}_1 r_1 + \widehat{w}_2 r_2 + \ldots.. + \widehat{w}_n r_n \qquad \hat{w}_j = \frac{N_j \cdot P(r_j)}{\sum_{i=1}^{n} N_i \cdot P(r_i)},\ 1 \le j \le n,$$

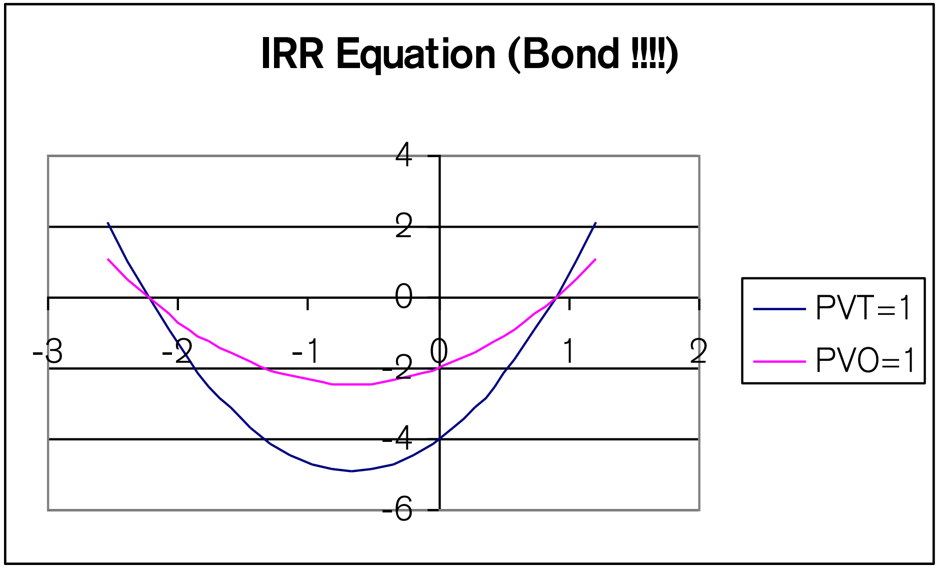
$$3.\ r_{dur} = \widetilde{w}_1 r_1 + \widetilde{w}_2 r_2 + \ldots.. + \widetilde{w}_n r_n \qquad \widetilde{w}_j = \frac{N_j P_j\, D^j_{Mac}}{\sum_{i=1}^{n} N_i P_i\, D^i_{Mac}},\ 1 \le j \le n$$

Actual Research

The internal rate of return (IRR)

One cash flow (The second solution surges !!!)

$PV_0 = 2,\ C_1 = 4/3,\ PV_2 = 1$ yields $r_1 = 0.11506,\ r_2 = -1.4484$



Different approximation schemes (IRR)

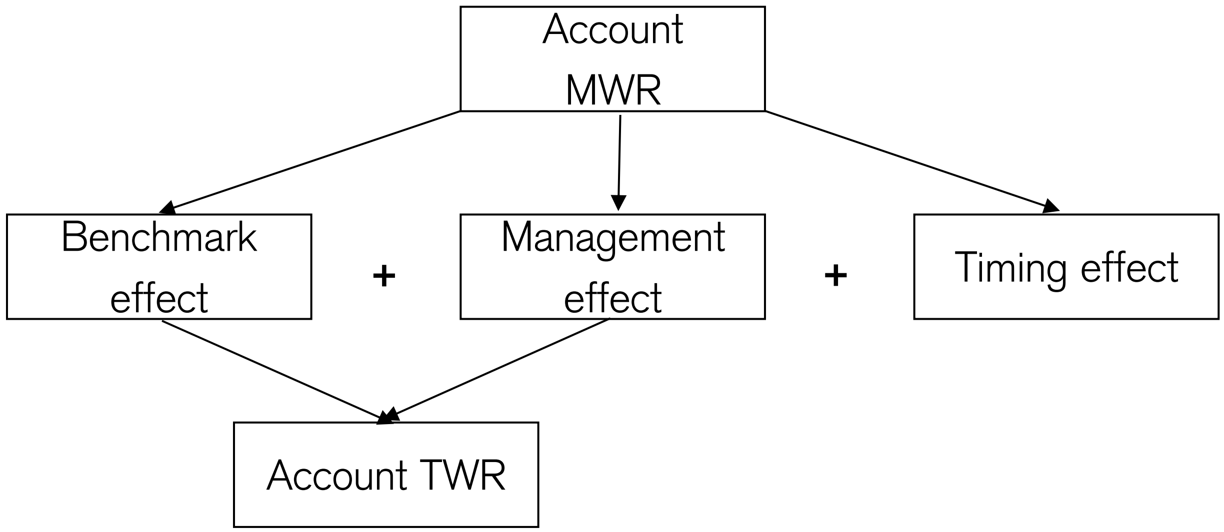
- IRR measures the return of a portfolio in a way that the return is ***sensitive*** to changes in the money invested

- IRR measures the return from a client's perspective where he does have control over the (external) cash flows

- IRR does not allow a comparison across peer groups

- calculating, decomposing and reporting MWRs is not common practice

The link between MWR and TWR



2. The Modern Portfolio Theorie (MPT)

Modern Portfolio Theory (MPT)

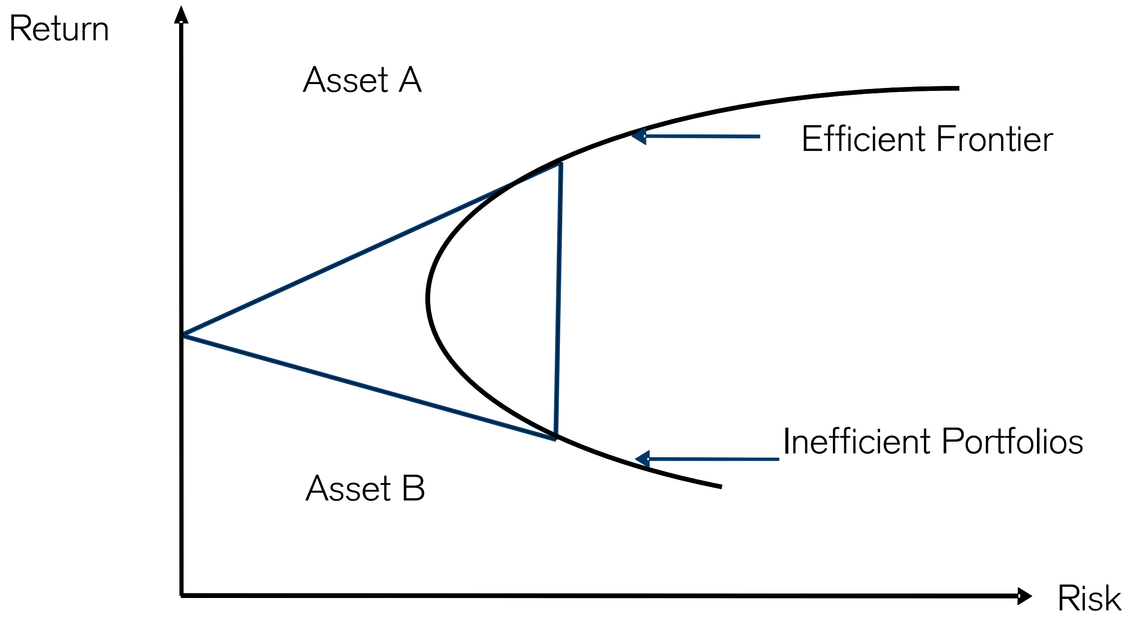
- MPT in a nutshell
  - We maximize return given the risk
  - We minimize risk given the return

- The standard model is

$$w_i \geqslant 0 \text{ Non-negativity,} \quad \sum_{i=1}^{n} w_i = 1 \quad \text{Budget.}$$

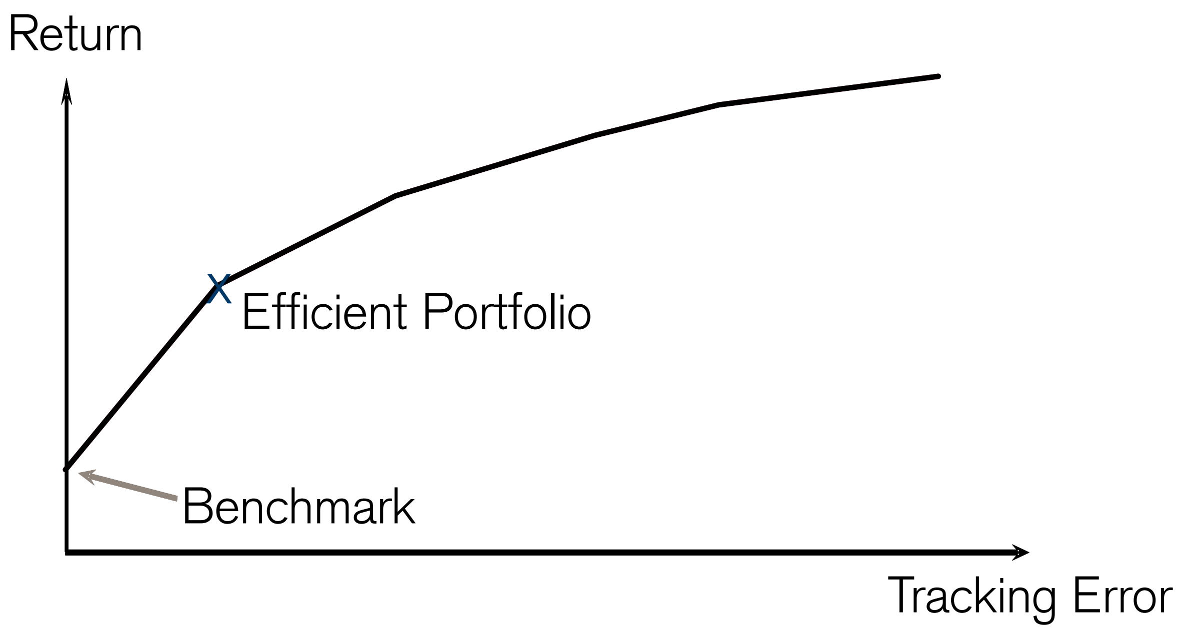
- The Black Model doesn’t reflect the Non-negativity

Absolute Optimization



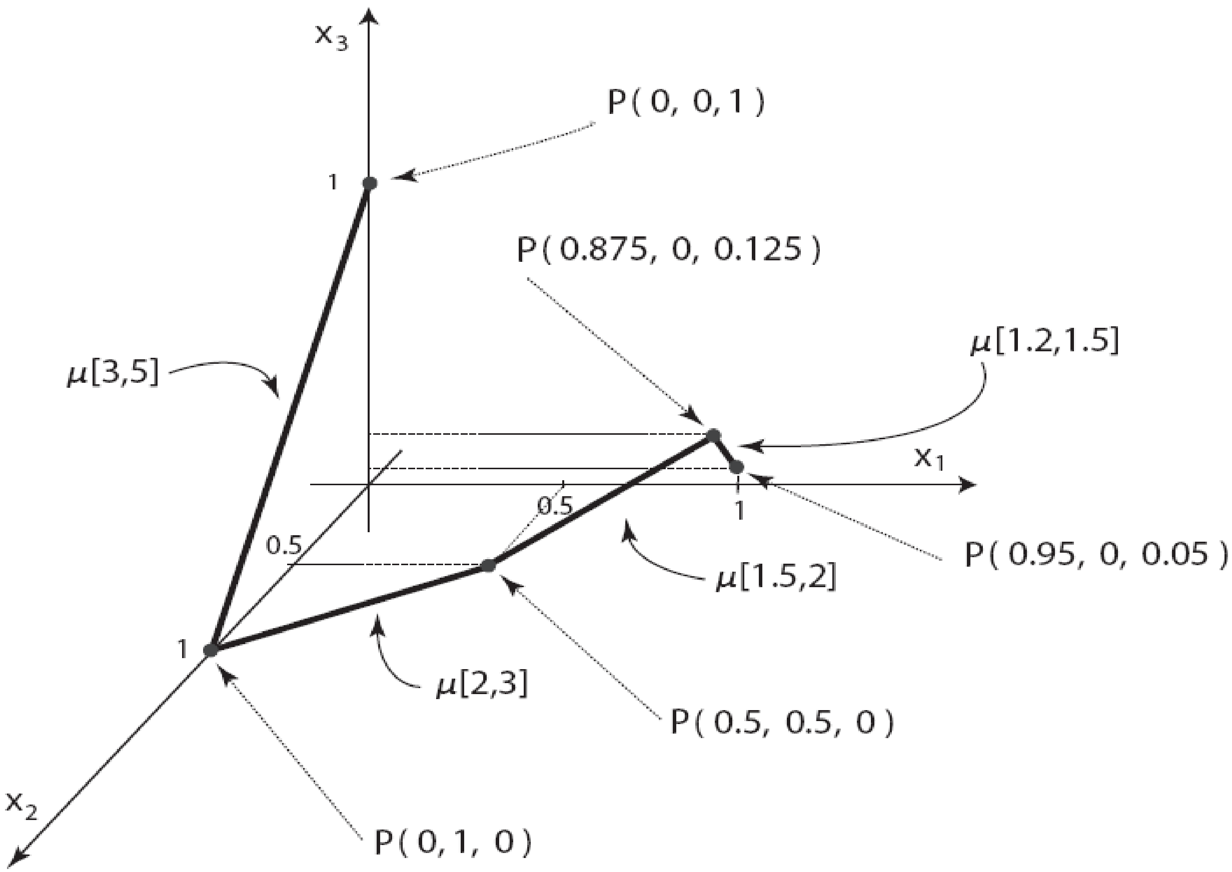
- Oversimplification
- Vary over the weights
- Minimum Variance

Relative Optimization

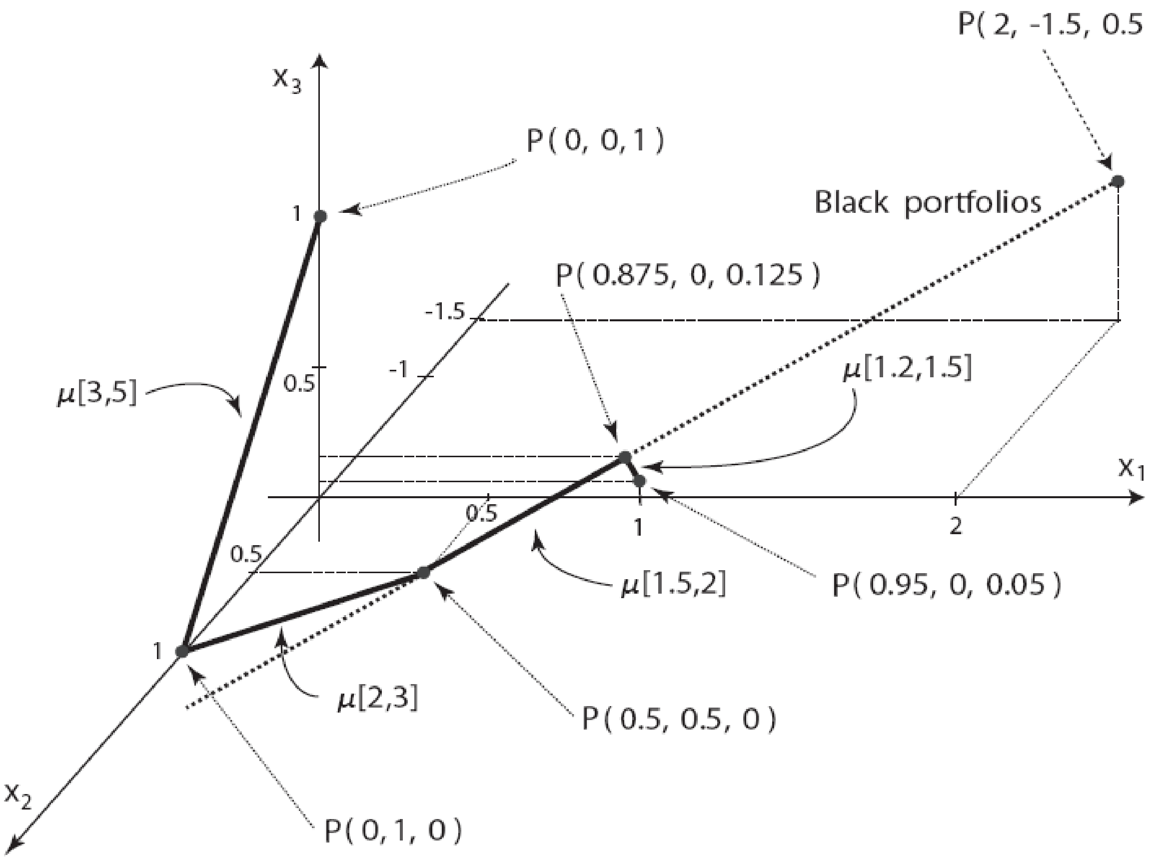


- Benchmark is independent of the forecast

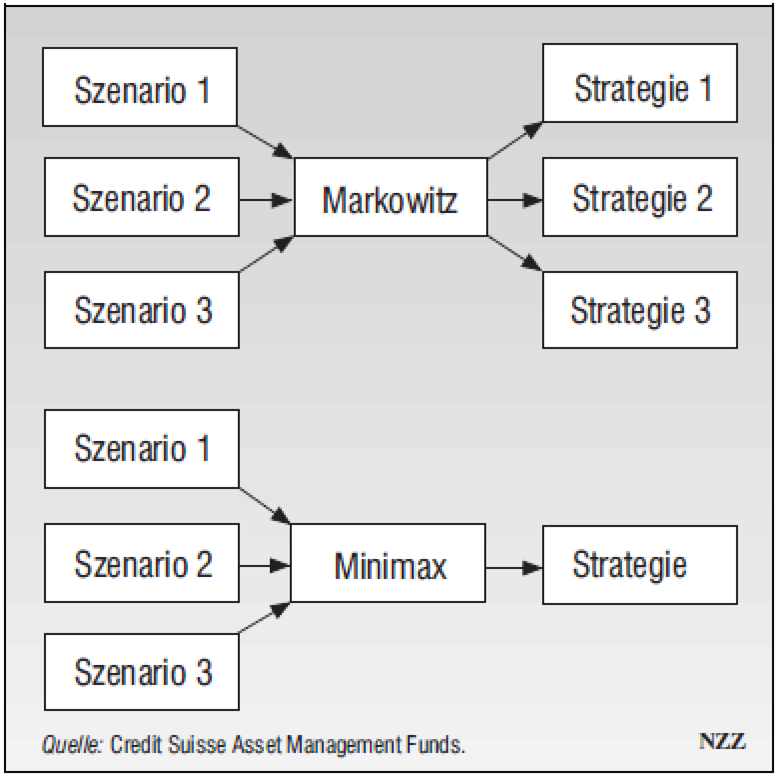
Differentiability of the efficient frontier



Differentiability of the efficient frontier

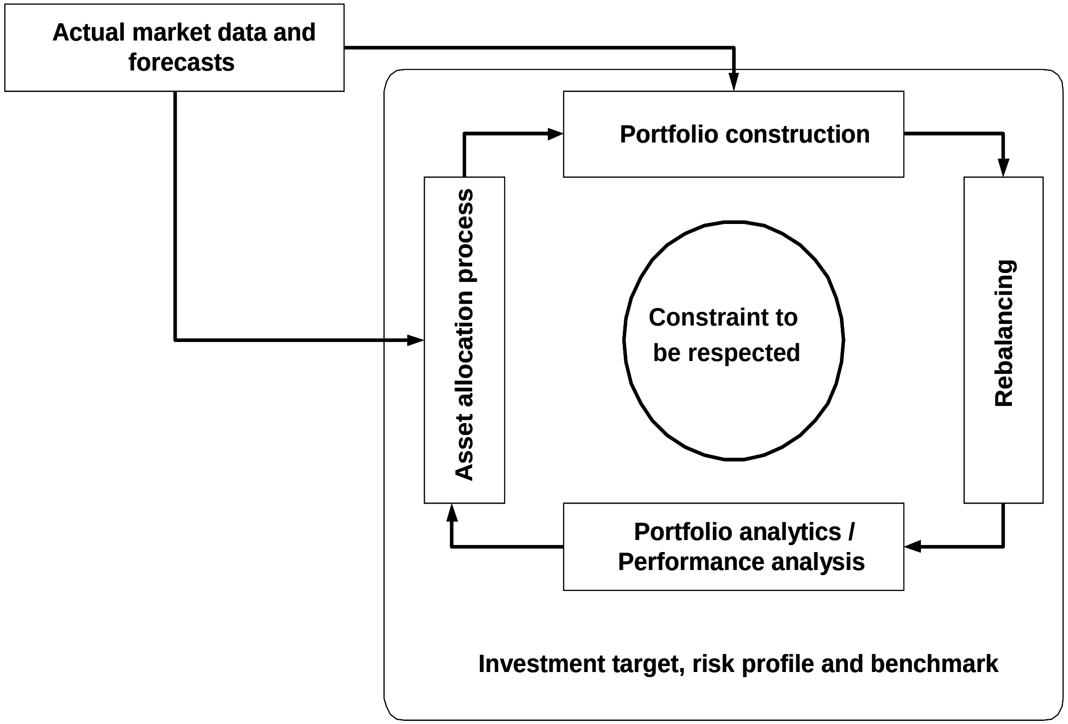


The Minimax Strategy

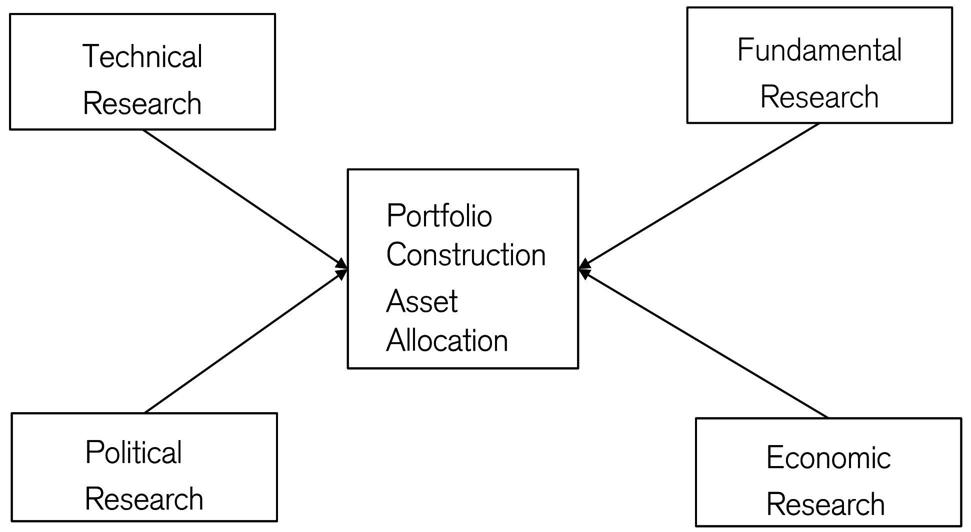


3. The investment process

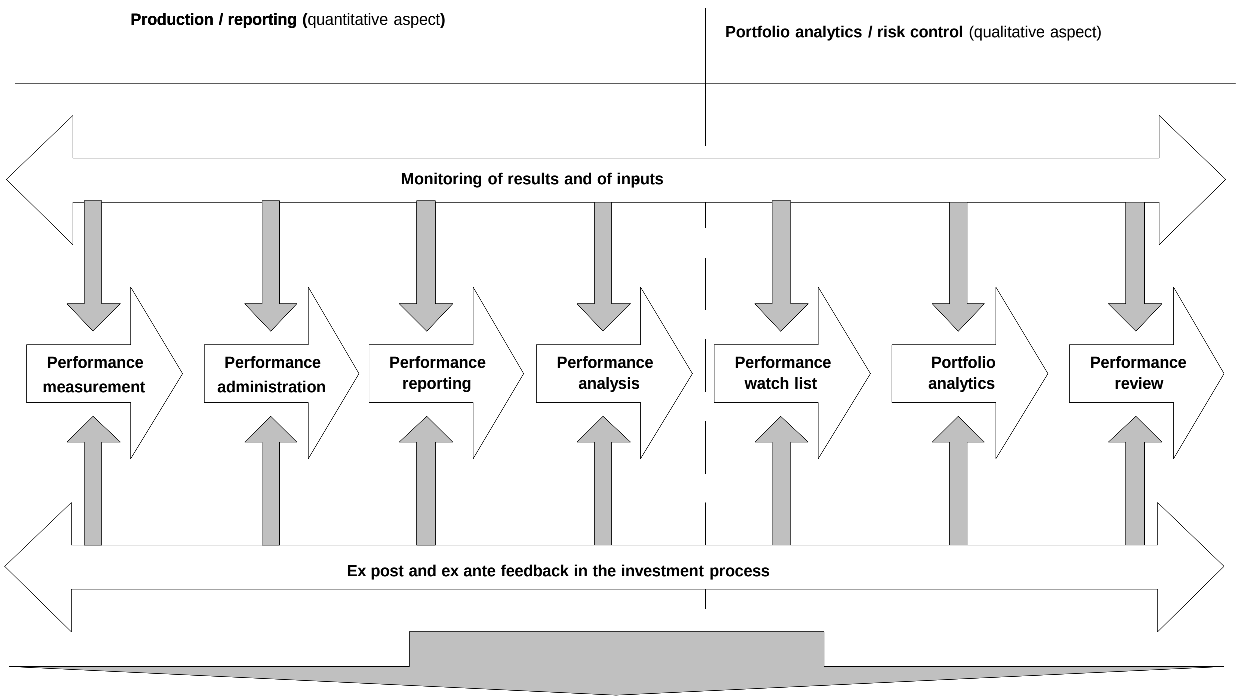
The Investment process



The Investment process



The Investment process



Efficient controlling of the forecast and investment process outcome

4. Summary and concluding remarks

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- **Email: wolfgang.marty@bluewin.ch**

Greetings from Swiss Bond Commission (SBC)