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IRR Attribution

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Introduction

Initial comments on TWR attribution

Decomposing the TWR is common practice and the main method implemented by performance attribution software providers, means that:

- Portfolio and benchmark returns are TWRs.
- Segment and stock returns are TWRs.
- Return contributions are calculated using TWRs.
- Use of TWRs assumes that portfolio manager has no discretion over any (external as well as internal) cash flows.
- Impact of internal as well as external cash flows are neutralized.
- Impact of over- / underweighting of segments or stocks is dealt by using weights instead of cash flows.

Initial comments on MWR attribution

Decomposing the MWR is not common practice and not offered by performance attribution software providers, means that:

- Decomposing the MWR or TWR using the "MWR-concept" is not common practice.
- The effect of cash flows is not allocated properly.
- The management effects may be misleading.

Initial comments on MWR

Money-weighted rate of return (MWR) measures the return of a portfolio in a way that the return is sensitive to changes in the money invested:

- MWR measures the return from a client's perspective where he does have control over the (external) cash flows.
- MWR does not allow a comparison across peer groups.
- MWR does allow a comparison against a benchmark (adjusted for cash flows).
- MWR is best measured by the internal rate of return (IRR).
- Calculating, decomposing and reporting MWRs is not common practice.
- MWRs are not generally covered by the GIPS Standards - just for private equity and closed end real estate funds.

Decomposition of MWR versus TWR

The MWR allows a decomposition of the portfolio return reflecting the client's main investment decision:

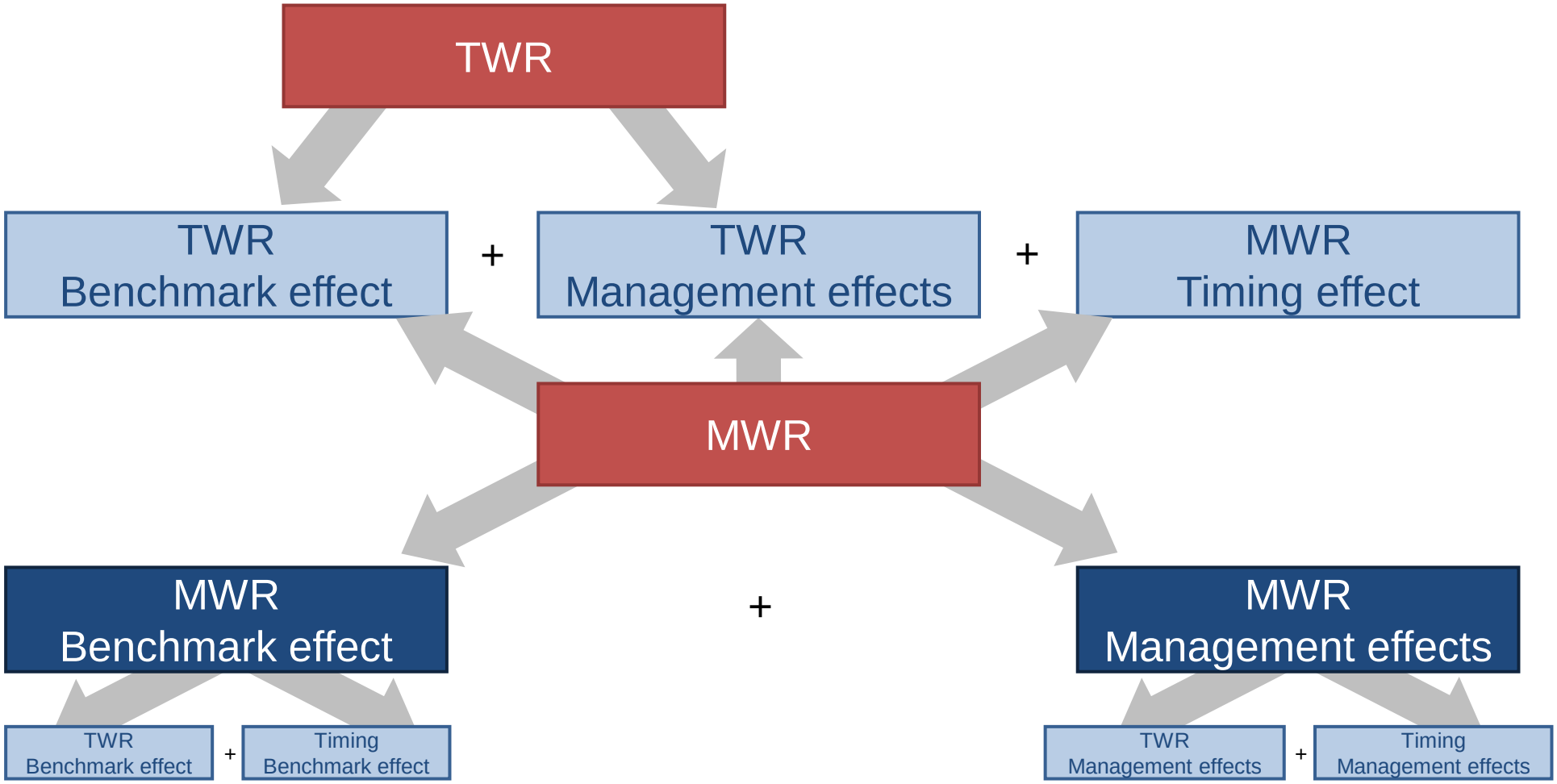
- TWR Benchmark effect => reflects the return contribution based on the client's decision to invest his initial capital into a specific benchmark strategy (corresponds to the TWR benchmark return).
- TWR Management effect => reflects the return contribution based on deviating from the benchmark strategy by asset allocation and stock picking (corresponds to the TWR attribution effects).
- MWR Timing effect => reflects the return contribution of changing the initial invested capital into the benchmark strategy and into the asset allocation of the portfolio (corresponds to the difference between MWR and TWR).

Decomposition of MWR – Another perspective

The MWR allows also a decomposition of the portfolio return without explicitly separating the timing effect:

- MWR Benchmark effect => reflects the return contribution based on the client's decision to invest his capital into a specific benchmark strategy (including the effect of changing the initial invested capital).
- MWR Management effect => reflects the return contribution based on deviating from the benchmark strategy by asset allocation and stock picking (including the effect of changing the initial invested capital).

Comparison of different decomposition approaches



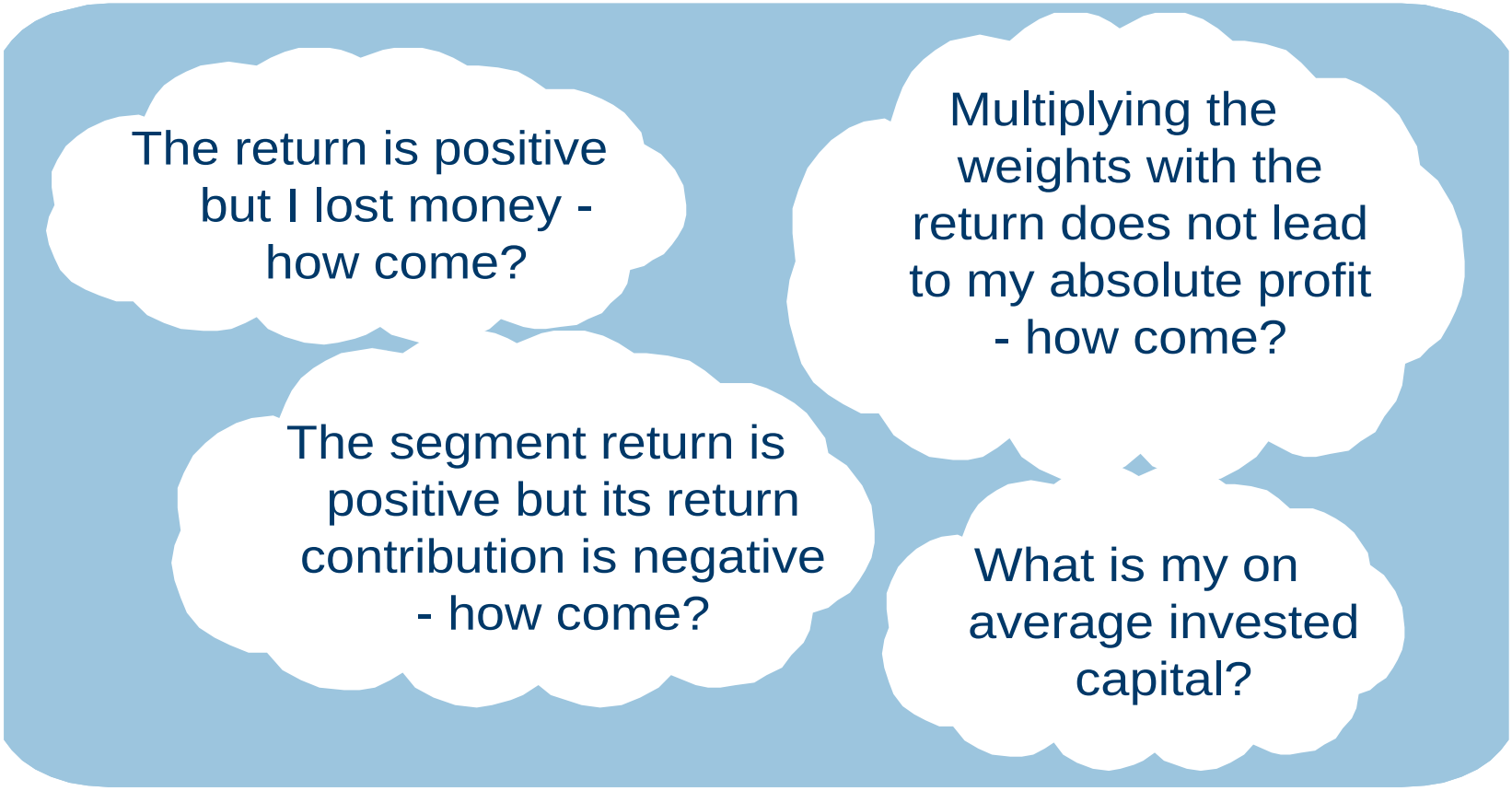
General framework for decomposing returns (1/2)

The MWR-calculation and MWR-attribution allow to define a general framework for decomposing returns:

- That combines the different views on performance (client versus portfolio manager).
- That connects the different return measurement methods (TWR and MWR).
- That connects the different return attribution methods (TWR and MWR).
- That corresponds to absolute profit & loss measurement and profit & loss attribution.
- Etc.

General framework for decomposing returns (2/2)

"Odd" questions can be better answered using the general framework for decomposing returns; including MWRs!



Calculation of IRR

First step towards IRR attribution

- Calculation of the IRR for the portfolio.
- Calculation of the IRR for the benchmark

  => by simulating the portfolio's cash in- and outflows also for the benchmark.
- Calculation of the excess IRR.

Calculation of the IRR for the portfolio (1/2)

$$0 = \frac{EMV_P}{(1+IRR_P)^{Y_T}} + \left(\sum_{t=1}^{T-1} \frac{-C_{P,t}}{(1+IRR_P)^{Y_{t-0}}} \right) - BMV_P$$

To calculate the MWR, in the industry different methodologies are used where all but one are approximation methods for the “true” MWR. In the following the internal rate of return methodology (IRR) as the "true" MWR is used because it is not only the most precise method for calculating a MWR but the one methodology that solves the full calculation problem. The IRR is the return / interest rate that causes the ending market value and intermediate cash flows to be discounted to the beginning market value.

Calculation of the IRR for the portfolio (2/2)

BMV_P = *Portfolio beginning market value.*
EMV_P = *Portfolio ending market value at T.*
IRR_P = *IRR of portfolio.*
$C_{P,t}$ = *Portfolio cash flow at t.*
Y_T = *Length of measurement period (to be measured in years – 365).*
Y_{t-0} = *Length of time period between the beginning of the measurement period and the date of the cash flow (to be measured in years – 365).*

Calculation of the IRR for the benchmark

$$0 = \frac{EMV_B}{(1+IRR_B)^{Y_T}} + \left(\sum_{t=1}^{T-1} \frac{-C_{B,t}}{(1+IRR_B)^{Y_{t-0}}} \right) - BMV_B$$

$$where: \; C_{B,t} = C_{P,t}$$

BMV_B = *Benchmark beginning market value.*
EMV_B = *Benchmark ending market value at T.*
IRR_B = *IRR of benchmark.*
$C_{B,t}$ = *Benchmark cash flow at t.*

Here it is important that the cash inflows (outflows) are invested (de-invested) according to the actual benchmark asset allocation at the time of the cash flow and that the returns of the money invested equal the respective returns of the underlying benchmark investments. In addition cash flows have to be simulated for rebalancing activities.

Calculation of the excess IRR

$$EIRR_P = IRR_P - IRR_B$$

$EIRR_P$ = *Excess IRR.*

Contribution to IRR

Second step towards IRR attribution

- Calculation of the profit and loss of the different asset classes.
- Calculation of the average invested capital for the different asset classes.
- Calculation of the asset class contribution to the IRR for the portfolio.
- Calculation of the asset class contribution to the IRR for the benchmark.
- Calculation of the asset class contribution to the excess IRR.

Calculation of the profit and loss

$$PL_P = EMV_P - BMV_P - \sum_{t=1}^{T-1} C_{P,t}$$

PL_P = *Profit and loss of portfolio.*

$$PL_P = \sum_{i=1}^{n} PL_{P,i} = \sum_{i=1}^{n} \left(EMV_{P,i} - BMV_{P,i} - \sum_{t=i}^{T-1} C_{P,i,t} \right)$$

$PL_{P,i}$ = *Profit and loss of asset class i.*
$EMV_{P,i}$ = *Ending market value of asset class i.*
$BMV_{P,i}$ = *Beginning market value of asset class i.*
$C_{P,i,t}$ = *Cash flow of asset class i at t.*
n = *Number of asset classes.*

Same formulas apply for the benchmark

Calculation of the average invested capital (1/3)

$$AIC_P = \frac{PL_P}{IRR_P}$$

AIC_P = *Average invested capital of portfolio.*

$$AIC_{P,i} = \frac{PL_{P,i}}{IRR_{P,i}}$$

$AIC_{P,i}$ = *Average invested capital of asset class i.*
$IRR_{P,i}$ = *IRR of asset class i.*

Basic idea: Within the IRR framework every cash flow series can be transferred to a cash flow series consisting of two cash flows - the cash inflow at the beginning of the investment period and a cash outflow at the end of the investment period. For such a cash flow series the average invested capital is equal to the cash inflow at the beginning of the investment period.

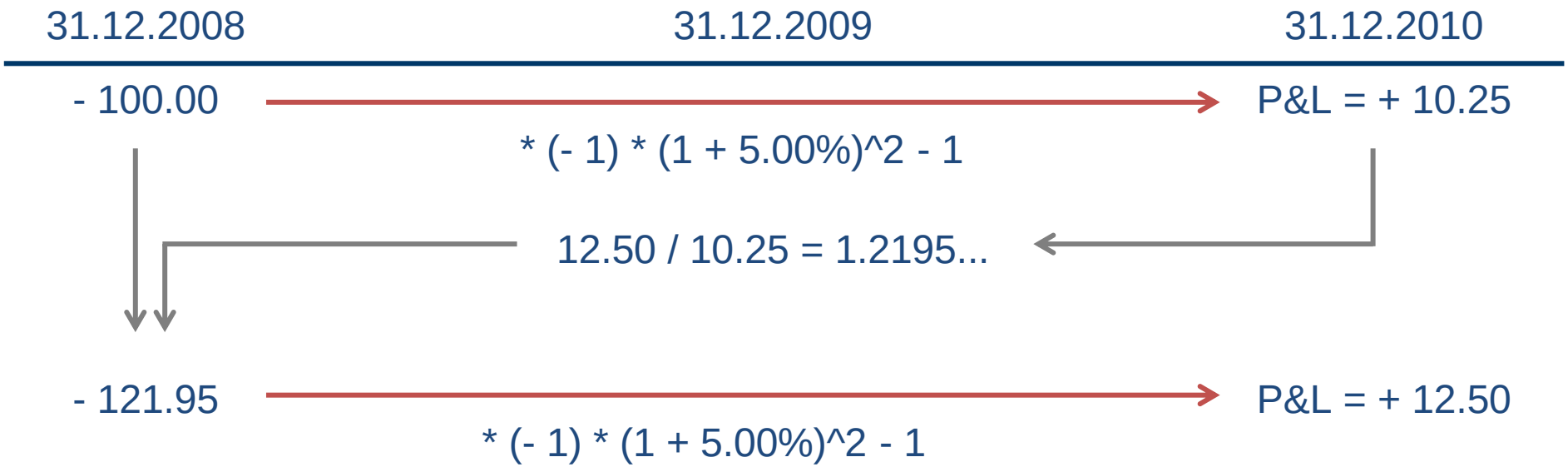
Same formulas apply for the benchmark

Calculation of the average invested capital (2a/3)

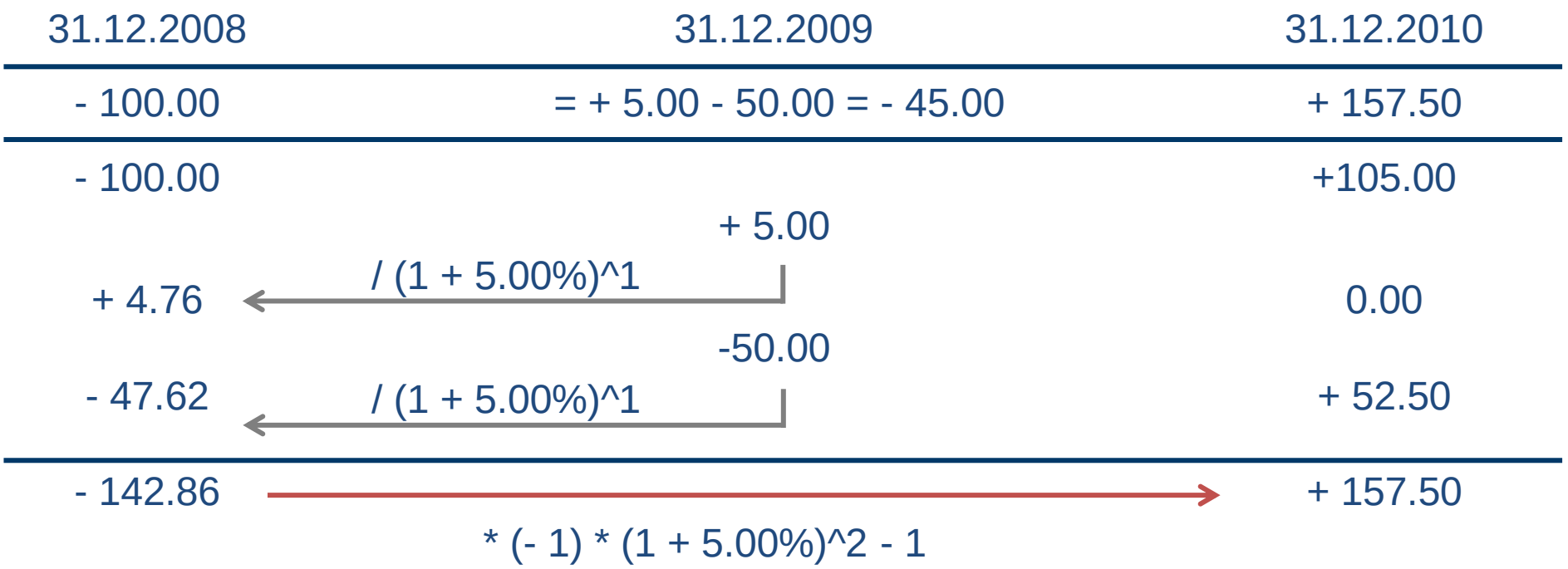
31.12.2008	31.12.2009	31.12.2010
- 100.00	= + 5.00 - 50.00 = - 45.00	+ 157.50
		P&L = + 12.50 and IRR = 5.00%

31.12.2008	31.12.2009	31.12.2010
- 100.00	= + 5.00 - 50.00 = - 45.00	+ 157.50
	Compounded with cost of capital - here equals IRR	* (1 + 5.00%) → - 47.25
- 100.00	← * (- 1) / (1 + 5.00%)^2	+ 110.25
		IRR = 5.00%

Calculation of the average invested capital (2b/3)



Calculation of the average invested capital (2c/3)



Remark: 142.86 is not the "correct" AIC for the relevant cash flow stream as the P&L is not 12.50 but instead 14.64. The difference is due to the interest costs or earnings of the interim cash flows - here for the first period (- 0.24 and + 2.38).
Interpretations: One could have earned absolute 2.14 more if 45.00 where also available for investment in the first period (increasing AIC from 121.95 to 142.86).

Calculation of the average invested capital (3/3)

$$AIC_P^1 = \frac{12.50}{(1+5.00\%)^2 - 1} = \frac{12.50}{10.25\%} = 121.95 \Leftrightarrow$$

$$AIC_P^2 = \frac{10.25}{(1+5.00\%)^2 - 1} = \frac{10.25}{10.25\%} = 100.00$$

$$IRR_P^1 = IRR_P^2 \Leftrightarrow \frac{PL_P^1}{AIC_P^1} = \frac{PL_P^2}{AIC_P^2} \Leftrightarrow AIC_P^1 = AIC_P^2 \times \frac{PL_P^1}{PL_P^2}$$

In absolute terms the average invested capital (AIC) of the two cash flow streams (the original and the transferred one) are not identical but the AIC as well as the absolute profit and loss are multiples of each other driven by the ratio between the different P&L figures.

Calculation of the contribution to the IRR for the portfolio

$$IRR_P = \frac{PL_P}{AIC_P} = \sum_{i=1}^{n} \frac{PL_{P,i}}{AIC_P} = \sum_{i=1}^{n} \frac{AIC_{P,i}}{AIC_P} \times IRR_{P,i} = \sum_{i=1}^{n} RC_{P,i}$$

$RC_{P,i}$ = *Contribution to IRR of asset class i.*

It is important to note that the average invested capital of the total portfolio does not have to be equal to the sum of the average invested capitals of all asset classes (due to the different implicit reinvestment assumptions).

$$AIC_P \leq or = or \geq \sum_{i=1}^{n} AIC_{P,i}$$

Calculation of the contribution to the IRR for the benchmark

$$IRR_B = \frac{PL_B}{AIC_B} = \sum_{i=1}^{n} \frac{PL_{B,i}}{AIC_B} = \sum_{i=1}^{n} \frac{AIC_{B,i}}{AIC_B} \times IRR_{B,i} = \sum_{i=1}^{n} RC_{B,i}$$

$RC_{B,i}$	*= Contribution to IRR of asset class i.*
PL_B	*= Profit and loss of benchmark.*
$PL_{B,i}$	*= Profit and loss of asset class i.*
AIC_B	*= Average invested capital of benchmark.*
$AIC_{B,i}$	*= Average invested capital of asset class i.*

Calculation of the contribution to the excess IRR

$$EIRR_P = IRR_P - IRR_B = \sum_{i=1}^{n} RC_{P,i} - \sum_{i=1}^{n} RC_{B,i}$$

$$EIRR_P = \sum_{i=1}^{n} \frac{AIC_{P,i}}{AIC_P} \times IRR_{P,i} - \sum_{i=1}^{n} \frac{AIC_{B,i}}{AIC_B} \times IRR_{B,i} = \sum_{i=1}^{n} \frac{PL_{P,i}}{AIC_P} - \sum_{i=1}^{n} \frac{PL_{B,i}}{AIC_B}$$

IRR attribution

Third and last step towards IRR attribution

Here the excess IRR is decomposed according to the Brinson, Hood and Beebower return attribution methodology and therefore split up into the asset allocation effect, stock picking effect and interaction effect.

$$EIRR_P = IRR_P - IRR_B = AAE_P + SPE_P + IAE_P = \sum_{i=1}^{n} AAE_{P,i} + \sum_{i=1}^{n} SPE_{P,i} + \sum_{i=1}^{n} IAE_{P,i}$$

AAE_P = *Asset allocation effect of portfolio.*
$AAE_{P,i}$ = *Asset allocation effect of asset class i.*
SPE_P = *Stock picking effect of portfolio.*
$SPE_{P,i}$ = *Stock picking effect of asset class i.*
IAE_P = *Interaction effect of portfolio.*
$IAE_{P,i}$ = *Interaction effect of asset class i.*

Simple framework for IRR attribution (1/5)

		Selection	
		Actual	Passive
Asset Allocation	Actual	**Quadrant IV** IRR of actual portfolio	**Quadrant II** IRR of notional portfolio 1 => active asset allocation portfolio
	Passive	**Quadrant III** IRR of notional portfolio 2 => active stock picking portfolio	**Quadrant I** IRR of benchmark

Simple framework for IRR attribution (2/5)

Quadrant IV represents the IRR of the actual portfolio which reflects all passive and active investment management decisions. The calculation of the IRR of the actual portfolio is based on the actual weights of the asset classes - expressed as cash flows - and the respective actual returns.	Quadrant II represents the IRR of the notional portfolio 1 which reflects the active asset allocation of the portfolio assuming no stock picking. The calculation of the IRR of the notional portfolio 1 is based on the actual weights of the asset classes - expressed as cash flows - and the respective passive index returns.
Quadrant III represents the IRR of the notional portfolio 2 which reflects the active stock picking of the portfolio assuming no active asset allocation. The calculation of the IRR of the notional portfolio 2 is based on the passive weights of the asset classes - expressed as cash flows - and the respective actual returns.	Quadrant I represents the IRR of the benchmark. The calculation of the IRR of the benchmark is based on the passive weights of the asset classes - expressed as cash flows - and the respective passive index returns.

Simple framework for IRR attribution (3/5)

$$AAE_P = Quadrant\ II - Quadrant\ I = IRR_{NP1} - IRR_B = \sum_{i=1}^{n} RC_{NP1,i} - \sum_{i=1}^{n} RC_{B,i}$$

IRR_{NP1} = *IRR of notional portfolio 1.*
$RC_{NP1,i}$ = *Contribution to IRR of asset class i.*

$$SPE_P = Quadrant\ III - Quadrant\ I = IRR_{NP2} - IRR_B = \sum_{i=1}^{n} RC_{NP2,i} - \sum_{i=1}^{n} RC_{B,i}$$

IRR_{NP2} = *IRR of notional portfolio 2.*
$RC_{NP2,i}$ = *Contribution to IRR of asset class i.*

Simple framework for IRR attribution (4/5)

$$IAE_P = Quadrant\ IV - Quadrant\ III - Quadrant\ II + Quadrant\ I$$

$$IAE_P = IRR_P - IRR_{NP2} - IRR_{NP1} + IRR_B$$

$$IAE_P = \sum_{i=1}^{n} RC_{P,i} - \sum_{i=1}^{n} RC_{NP2,i} - \sum_{i=1}^{n} RC_{NP1,i} + \sum_{i=1}^{n} RC_{B,i}$$

Simple framework for IRR attribution (5/5)

On an asset class level:

$$AAE_{P,i} = RC_{NP1,i} - RC_{B,i}$$

$$SPE_{P,i} = RC_{NP2,i} - RC_{B,i}$$

$$IAE_{P,i} = RC_{P,i} - RC_{NP2,i} - RC_{NP1,i} + RC_{B,i}$$

Hypothetical example

Hypothetical example – Assumptions (1/8)

- Sample multi-asset class portfolio is investing in two asset classes A and B.
- Relevant benchmark is also investing in these two asset classes A and B.
- The portfolio as well the benchmark are rebalanced on a yearly basis at the beginning of the calendar year.
- A two year period from 31.12.2006 until 31.12.2008 is considered.
- At the beginning of 2007 EUR 150 are invested in the portfolio.
- At the beginning of 2008 additional EUR 100 are invested into the portfolio according to the then current active asset allocation and stock pickings.

Hypothetical example – Return calculations (2a/8)

Actual Portfolio (IRR)			
	Period 1	**Period 2**	
Dates	31.12.2006	31.12.2007	31.12.2008
	Cash flow at beginning of period	Cash flow at beginning of period	Market value at the end of period
Asset A	-75.0	47.6	36.7
Asset B	-75.0	-147.6	240.8
Portfolio	-150.0	-100.0	277.5
	Actual weights at beginning of period	Actual weights at beginning of period	Weights at the end of period
Asset A	**50.0%**	**15.0%**	13.2%
Asset B	**50.0%**	**85.0%**	86.8%
Portfolio	100.0%	100.0%	100.0%
	Actual return	Actual return	Cummulative return
Asset A	**15.0%**	**-5.0%**	17.9%
Asset B	**-5.0%**	**10.0%**	12.4%
Portfolio	5.0%	7.8%	13.8%

Remark: negative (positive) cash flow means cash inflow (outflow).

Hypothetical example – Return calculations (2b/8)

Actual Portfolio (IRR)			
	Period 1	**Period 2**	
Dates	31.12.2006	31.12.2007	31.12.2008
	Cash flow at beginning of period	Cash flow at beginning of period	Market value at the end of period
Asset A	-75.0	47.6	36.7
Asset B	-75.0	-147.6	240.8
Portfolio	-150.0	-100.0	277.5
	Actual weights at beginning of period		
Asset A	**50.0%**		
Asset B	**50.0%**		
Portfolio	100.0%		
	Actual return	Actual return	Cummulative return
Asset A	**15.0%**	**-5.0%**	17.9%
Asset B	**-5.0%**	**10.0%**	12.4%
Portfolio	5.0%	7.8%	13.8%

$$75 \times (1 + 15\%) - 15\% \times [150 \times (1 + 5\%) + 100]$$
$$= 86.25 - 15\% \times (157.5 + 100)$$
$$= 86.25 - 38.625 = 47.625$$

Remark: negative (positive) cash flow means cash inflow (outflow).

Hypothetical example – Return calculations (3/8)

Benchmark (IRR)			
	Period 1	**Period 2**	
Dates	31.12.2006	31.12.2007	31.12.2008
	Cash flow at beginning of period	Cash flow at beginning of period	Market value at the end of period
Asset A	-45.0	-39.5	83.0
Asset B	-105.0	-60.6	167.2
Portfolio	-150.0	-100.0	250.2
	Passive weights at beginning of period	Passive weights at beginning of period	Weights at the end of period
Asset A	**30.0%**	**30.0%**	33.2%
Asset B	**70.0%**	**70.0%**	66.8%
Portfolio	100.0%	100.0%	100.0%
	Passive return	Passive return	Cummulative return
Asset A	**-20.0%**	**10.0%**	-2.2%
Asset B	**10.0%**	**-5.0%**	1.3%
Portfolio	1.0%	-0.5%	0.1%

Remark: negative (positive) cash flow means cash inflow (outflow).

Hypothetical example – Return calculations (4/8)

Notional Portfolio 1 (IRR)			
	Period 1	**Period 2**	
Dates	31.12.2006	31.12.2007	31.12.2008
	Cash flow at beginning of period	Cash flow at beginning of period	Market value at the end of period
Asset A	-75.0	23.6	40.0
Asset B	-75.0	-123.6	195.8
Portfolio	-150.0	-100.0	235.8
	Actual weights at beginning of period	Actual weights at beginning of period	Weights at the end of period
Asset A	**50.0%**	**15.0%**	17.0%
Asset B	**50.0%**	**85.0%**	83.0%
Portfolio	100.0%	100.0%	100.0%
	Passive return	Passive return	Cummulative return
Asset A	**-20.0%**	**10.0%**	-18.2%
Asset B	**10.0%**	**-5.0%**	-2.0%
Portfolio	-5.0%	-2.8%	-7.0%

Remark: negative (positive) cash flow means cash inflow (outflow).

Hypothetical example – Return calculations (5/8)

Notional Portfolio 2 (IRR)			
	Period 1	**Period 2**	
Dates	31.12.2006	31.12.2007	31.12.2008
	Cash flow at beginning of period	Cash flow at beginning of period	Investment at the end of period
Asset A	-45.0	-23.7	71.7
Asset B	-105.0	-76.3	193.7
Portfolio	-150.0	-100.0	265.3
	Passive weights at beginning of period	Passive weights at beginning of period	Weights at the end of period
Asset A	**30.0%**	**30.0%**	27.0%
Asset B	**70.0%**	**70.0%**	73.0%
Portfolio	100.0%	100.0%	100.0%
	Actual return	Actual return	Cummulative return
Asset A	**15.0%**	**-5.0%**	5.2%
Asset B	**-5.0%**	**10.0%**	8.7%
Portfolio	1.0%	5.5%	7.7%

Remark: negative (positive) cash flow means cash inflow (outflow).

Hypothetical example – Management effects (6/8)

Actual Portfolio (IRR)				
	P&L	AIC	IRR	RC
Asset A	9.3	52.1	17.9%	4.7%
Asset B	18.1	146.8	12.4%	9.1%
Portfolio	27.5	198.4	13.8%	13.8%

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Benchmark (IRR)				
	P&L	AIC	IRR	RC
Asset A	-1.5	64.9	-2.2%	-0.7%
Asset B	1.7	135.2	1.3%	0.8%
Portfolio	0.2	200.1	0.1%	0.1%

Hypothetical example – Management effects (7/8)

Notional Portfolio 1 (IRR)				
	P&L	AIC	IRR	RC
Asset A	-11.4	62.6	-18.2%	-5.7%
Asset B	-2.8	137.2	-2.0%	-1.4%
Portfolio	-14.2	201.0	-7.0%	-7.0%
Notional Portfolio 2 (IRR)				
	P&L	AIC	IRR	RC
Asset A	3.0	56.7	5.2%	1.5%
Asset B	12.4	142.4	8.7%	6.2%
Portfolio	15.3	199.1	7.7%	7.7%

Hypothetical example – Management effects (8a/8)

Remark: Here high IAE due to the big shifts. in the asset allocation.

IRR-Attribution

	AAE	SPE	IAE	Total
Asset A	-4.9%	2.2%	8.1%	5.4%
Asset B	-2.2%	5.4%	5.2%	8.3%
Portfolio	-7.2%	7.6%	13.3%	13.7%

Remark: IRR figures are consistent with the absolute profit & loss figures – see appendix.

Profit and Loss Attribution

	AAE	SPE	IAE	Total
Asset A	-9.9	4.4	16.2	10.8
Asset B	-4.5	10.7	10.3	16.4
Portfolio	-14.4	15.1	26.5	27.2

Hypothetical example – Management effects (8b/8)

IRR-Attribution				
	AAE	SPE	IAE	Total
Asset A	-4.9%	2.2%	8.1%	5.4%
Asset B	-2.2%	5.4%	5.2%	8.3%
Portfolio	-7.2%	7.6%	13.3%	13.7%

Profit and Loss Attribution				
	AAE	SPE	IAE	Total
Asset A	-9.9			
Asset B	-4.5	10.7	10.3	16.4
Portfolio	-14.4	15.1	26.5	27.2

$$PL_{NP1} - PL_B = -11.4 - (-1.5) = -9.9$$

Simple example for an IRR implementation

Simple example for an IRR implementation (1/3)

before cash flow

Asset allocation in %	31.12.2009	31.03.2010	30.06.2010	30.09.2010	31.12.2010
Cash	-	99.50	99.00	98.51	98.01
Bonds	-	618.00	624.18	314.45	308.17
Equities	-	255.00	234.60	918.06	1'009.87
Total portfolio	-	972.50	957.78	1'331.02	1'416.05

Cash flows	31.12.2009	31.03.2010	30.06.2010	30.09.2010	31.12.2010
Cash	100.00	-	-	-	-
Bonds	600.00	-	-300.00	-	-
Equities	300.00	-	600.00	-	-
Total portfolio	1'000.00	-	300.00	-	-

after cash flow

Asset allocation in %	31.12.2009	31.03.2010	30.06.2010	30.09.2010	31.12.2010
Cash	100.00	99.50	99.00	98.51	98.01
Bonds	600.00	618.00	324.18	314.45	308.17
Equities	300.00	255.00	834.60	918.06	1'009.87
Total portfolio	1'000.00	972.50	1'257.78	1'331.02	1'416.05

Investment returns	31.12.2009	31.03.2010	30.06.2010	30.09.2010	31.12.2010
Cash		-0.50%	-0.50%	-0.50%	-0.50%
Bonds		3.00%	1.00%	-3.00%	-2.00%
Equities		-15.00%	-8.00%	10.00%	10.00%
Total portfolio		-2.75%	-1.51%	5.82%	6.39%

Simple example for an IRR implementation (2/3)

Remark: negative (positive) cash flow means cash inflow (outflow).

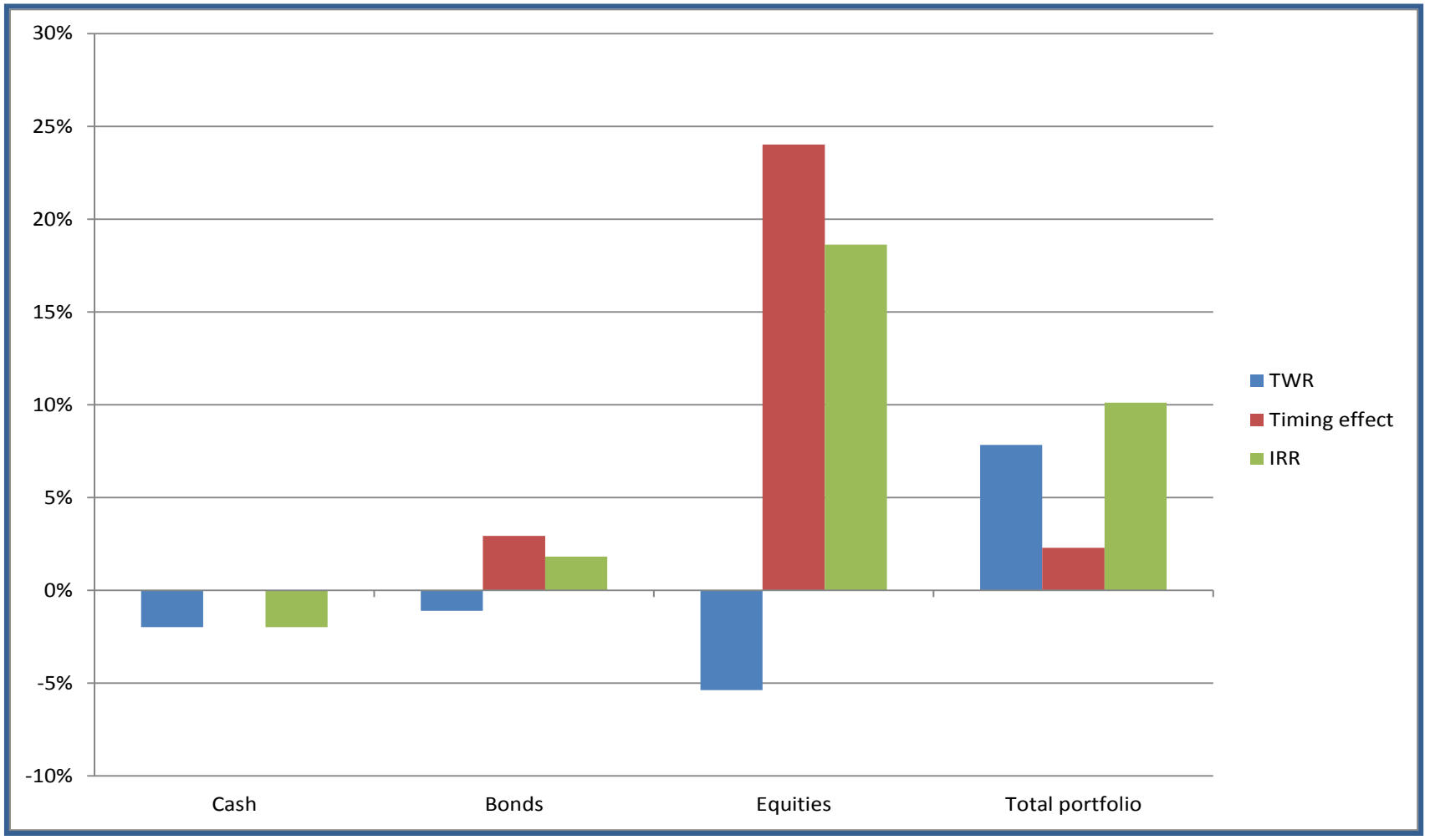
Cash flows for IRR	31.12.2009	31.03.2010	30.06.2010	30.09.2010	31.12.2010
Cash	-100.00	-	-	-	98.01
Bonds	-600.00	-	300.00	-	308.17
Equities	-300.00	-	-600.00	-	1'009.87
Total portfolio	-1'000.00	-	-300.00	-	1'416.05

	Profit & Loss	TWR	Timing effect	IRR	Contribution to IRR
Cash	-1.99	-1.99%	0.00%	-1.99%	-0.17%
Bonds	8.17	-1.11%	2.93%	1.82%	0.71%
Equities	109.87	-5.38%	24.01%	18.63%	9.57%
Total portfolio	116.05	7.83%	2.28%	10.11%	10.11%

Investment Reporting based on TWR shows wondrous results:

- Negative TWR but absolute profit for bonds and equities.
- Negative TWRs for all asset classes but positive TWR for the total portfolio.
- …

Simple example for an IRR implementation (3/3)



Critical aspects

Critical aspects

- Unrealistic (re-)investment assumption:
  => explicit / realistic (re-)investment assumptions (MIRR).
- Multiple solutions for IRR:
  => explicit / realistic (re-)investment assumptions.
- IRR for benchmarks:
  => public market equivalent (PME) used in private equity industry.
- Peer group comparison:
  => IRR not designed for peer analysis.
- Risk measurement:
  => IRR not designed for dispersion analytics.
- Implied interim asset values differ from true interim asset value
  => IRR is designed as an average return for the reporting period.
- ...

Comments and questions

Appendix: Profit and loss attribution

Last step towards profit and loss attribution

Here the excess profit and loss is decomposed according to the Brinson, Hood and Beebower return attribution methodology and therefore split up into the asset allocation effect, stock picking effect and interaction effect.

$$EPL_P = PL_P - PL_B = AAPL_P + SPPL_P + IAPL_P$$
$$= \sum_{i=1}^{n} AAPL_{P,i} + \sum_{i=1}^{n} SPPL_{P,i} + \sum_{i=1}^{n} IAPL_{P,i}$$

$AAPL_P$ = *Profit and loss of portfolio due to asset allocation.*
$AAPL_{P,i}$ = *Profit and loss of asset class i due to asset allocation.*
$SPPL_P$ = *Profit and loss of portfolio due to stock picking.*
$SPPL_{P,i}$ = *Profit and loss of asset class i due to stock picking.*
$IAPL_P$ = *Profit and loss of portfolio due to interaction.*
$IAPL_{P,i}$ = *Profit and loss of asset class i due to interaction.*

Simple framework for profit and loss attribution (1/5)

		Selection	
		Actual	Passive
Asset Allocation	Actual	**Quadrant IV** P&L of actual portfolio	**Quadrant II** P&L of notional portfolio 1 => active asset allocation portfolio
	Passive	**Quadrant III** P&L of notional portfolio 2 => active stock picking portfolio	**Quadrant I** P&L of benchmark

Simple framework for profit and loss attribution (2/5)

Quadrant IV represents the P&L of the actual portfolio which reflects all passive and active investment management decisions. The calculation of the P&L of the actual portfolio is based on the actual weights of the asset classes - expressed as cash flows - and the respective actual returns.

Quadrant II represents the P&L of the notional portfolio 1 which reflects the active asset allocation of the portfolio assuming no stock picking. The calculation of the P&L of the notional portfolio 1 is based on the actual weights of the asset classes - expressed as cash flows - and the respective passive index returns.

Quadrant III represents the P&L of the notional portfolio 2 which reflects the active stock picking of the portfolio assuming no active asset allocation. The calculation of the P&L of the notional portfolio 2 is based on the passive weights of the asset classes - expressed as cash flows - and the respective actual returns.

Quadrant I represents the P&L of the benchmark. The calculation of the P&L of the benchmark is based on the passive weights of the asset classes - expressed as cash flows - and the respective passive index returns.

Simple framework for profit and loss attribution (3/5)

$$AAPL_P = Quadrant\ II - Quadrant\ I = PL_{NP1} - PL_B = \sum_{i=1}^{n} PL_{NP1,i} - \sum_{i=1}^{n} PL_{B,i}$$

PL_{NP1} = *Profit and loss of notional portfolio 1.*
$PL_{NP1,i}$ = *Profit and loss of asset class i.*

$$SPPL_P = Quadrant\ III - Quadrant\ I = PL_{NP2} - PL_B = \sum_{i=1}^{n} PL_{NP2,i} - \sum_{i=1}^{n} PL_{B,i}$$

PL_{NP2} = *Profit and loss of notional portfolio 2.*
$PL_{NP2,i}$ = *Profit and loss of asset class i.*

Simple framework for profit and loss attribution (4/5)

$$IAPL_P = Quadrant\ IV - Quadrant\ III - Quadrant\ II + Quadrant\ I$$

$$IAPL_P = PL_P - PL_{NP2} - PL_{NP1} + PL_B$$

$$IAPL_P = \sum_{i=1}^{n} PL_{P,i} - \sum_{i=1}^{n} PL_{NP2,i} - \sum_{i=1}^{n} PL_{NP1,i} + \sum_{i=1}^{n} PL_{B,i}$$

Simple framework for profit and loss attribution (5/5)

On an asset class level:

$$AAPL_{P,i} = PL_{NP1,i} - PL_{B,i}$$

$$SPPL_{P,i} = PL_{NP2,i} - PL_{B,i}$$

$$IAPL_{P,i} = PL_{P,i} - PL_{NP2,i} - PL_{NP1,i} + PL_{B,i}$$

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