Video 1: Welcome to the course

About myself

- Professor of finance, Vrije Universiteit Brussel and Amsterdam;
- Inventor of statistical methodology for reliable financial decision
- Publications in the Journal of Portfolio Management and Review of Finance, among others.
- Contributor to the R packages PerformanceAnalytics, PortfolioAnalytics and highfrequency, among others.
- Consultancy to investment firms.

The importance of risk management

- Old Wall Street saying: “There are old traders and bold traders, but there are no old, bold traders.”

- Investment success is achieved by “Winning by losing less”

Approaches to avoiding large losses

- [1] Diversify investments: For most investments, there exists a well-diversified portfolio with a higher return and/or lower risk.

Approaches to avoiding large losses

- [2] Quantify the consequences of investment decisions:
  - Monitor past performance;
  - Estimate the future reward and risk of the investment.

This course

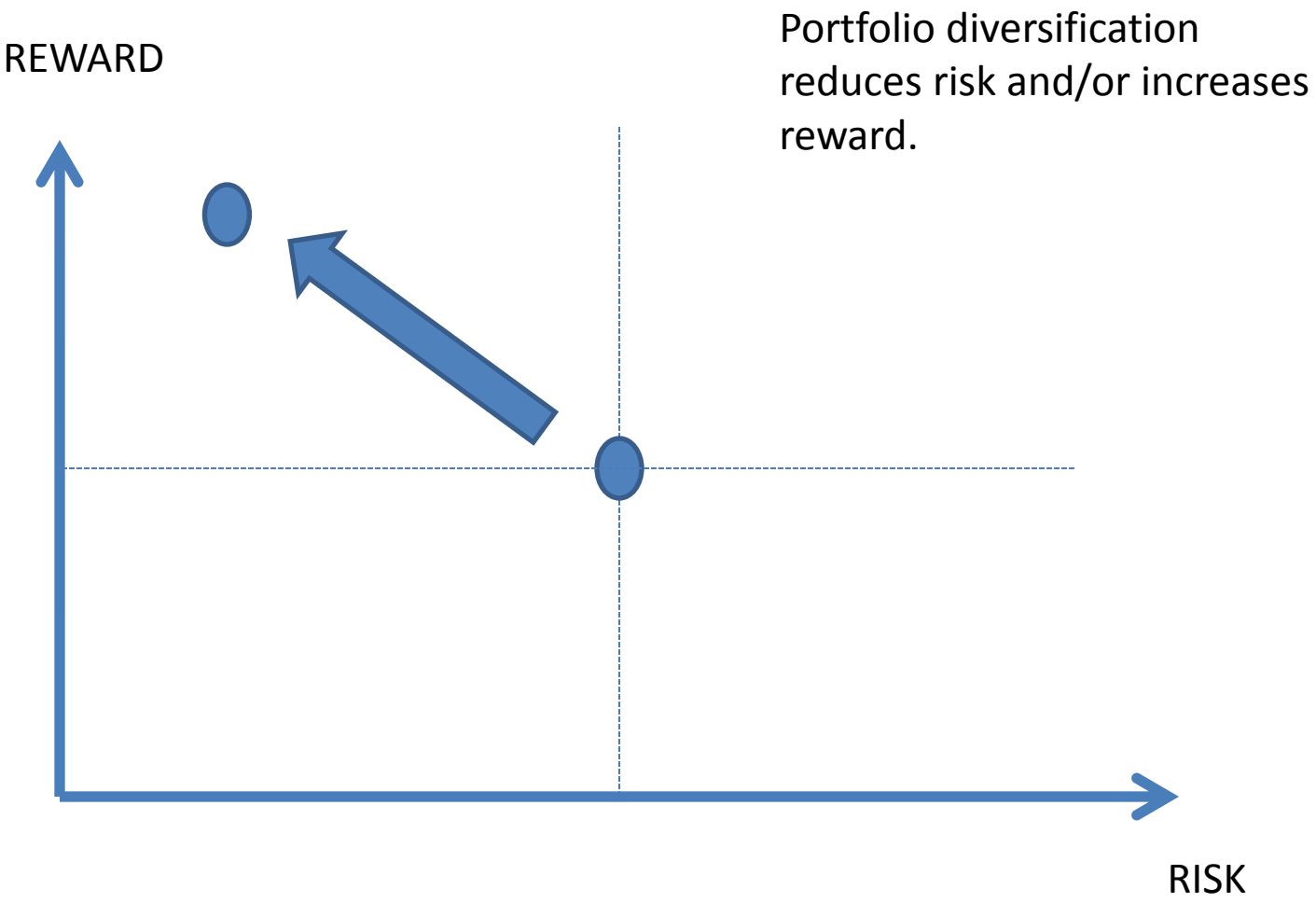
- Chapter 1
- Chapter 2
- Chapter 3
- Chapter 4

Video 2: The investment decision in a portfolio context

- Investing in the Coca Cola Company or PepsiCo?

- Nobel prize lecture of Robert Engle: “to avoid all risks would be impossible; it might entail no flying, no driving, no walking. Even a bath could be dangerous. There are some risks we choose to take because the benefits from taking them exceed the possible costs. The central paradigm of finance is that must take risks to achieve rewards **but not all risks are equally rewarded**.

The power of diversification

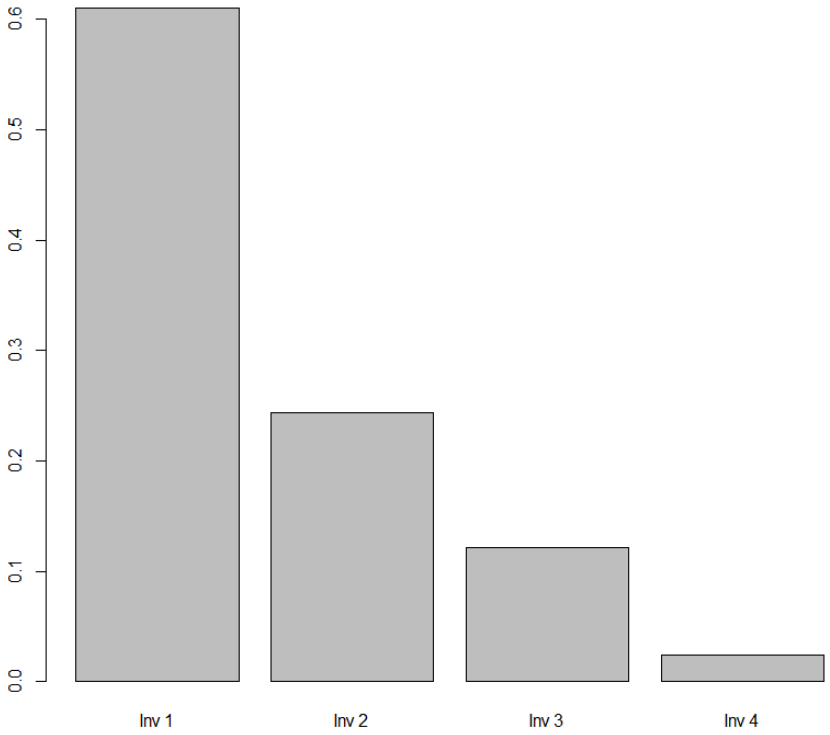


- Nobel prize lecture of Robert Engle: “it is easily observed that to avoid all risks would be impossible; it might entail no flying, no driving, no walking, eating and drinking only healthy foods and never being touched by sunshine. Even a bath could be dangerous. There are some risks we choose to take because the benefits from taking them exceed the possible costs. Optimal behavior takes risks that are worthwhile.”

Portfolio weights

Investment	Value invested	Weight
1	V_1	$w_1 = \frac{V_1}{V_1 + \cdots + V_N}$
2	V_2	$w_2 = \frac{V_2}{V_1 + \cdots + V_N}$
* * *		
N	V_N	$w_N = \frac{V_N}{V_1 + \cdots + V_N}$

```
values <- c(500000, 200000, 100000, 20000)
names(values) <- c("Inv 1","Inv 2","Inv 3","Inv 4")
weights <- values/sum(values)
barplot(weights)
```



- Descriptive analysis of weights shows the budget allocation.
- Weights are the decision variable.
- Examples of possible weight allocation decisions:

Speculation: Invest all your wealth in one single asset

Equal-weighting: Invest in all assets the same amount

Low risk approach: Overweight the less volatile stocks

The growth investor: Overweight assets with a high potential to increase their market value in the future.

Market capitalization based weighting: Set the weights of the assets relatively to their market value. Overweight large stocks, underweight small stocks

The small is beautifull investor: Overweight small stocks

The value investor: Overweight stocks with low price to earnings and price to book ratios.

- Important for us …

Video 3: One-period portfolio returns are the weighted average of the individual returns

- The investor decides on the portfolio weights
- These weights determine the change in portfolio value.
  - Backward looking questions:
  - Forward looking questions:

- Expressed in relative terms…

Simple returns over a one-period investment

	Initial Value	Final Value	Simple return
General formula	Vi	Vf	$R = \frac{Vf - Vi}{Vi}$
Example 1	100	120	(120-100)/100=0.2=20%
Example 2	1000	1020	(1020-1000)/1000=0.02=2%
Example 3	1000	980	-2%

- The portfolio return is the change in portfolio value relative to the initial value:

PORTFOLIO RETURN = (FINAL PORTFOLIO VALUE-INTIAL PORTFOLIO VALUE)/INITIAL PORTFOLIO VALUE

- This formula applies to any investment, and thus also for a portfolio:

Investment	Initial Value	Final Value	Return
1	Vi_1	VF_1	
2	Vi_2	Vf_2	
* * *			
N	Vi_N	Vf_N	
TOTAL	$Vi = Vi_1+\ldots+Vi_N$	$Vf = Vf_1+\ldots+Vf_N$	$R = (Vf-Vi)/Vi$

- Disadvange…

- Equivalence

PORTFOLIO RETURN
= (FINAL PORTFOLIO VALUE-INTIAL PORTFOLIO VALUE)/INITIAL PORTFOLIO VALUE
= weighted average return

Magic

Investment	Initial Value	Final Value	Return	weights
1	Vi_1	VF_1		$w_1 = \frac{Vi_1}{Vi_1 + \cdots + Vi_N}$
2	Vi_2	Vf_2		$w_2 = \frac{Vi_2}{Vi_1 + \cdots + Vi_N}$
* * *				
N	Vi_N	Vf_N		$w_N = \frac{Vi_N}{Vi_1 + \cdots + Vi_N}$
TOTAL	$Vi = Vi_1 + \ldots + Vi_N$	$Vf = Vf_1 + \ldots + Vf_N$	$R = (Vf - Vi)/Vi = \sum_{i=1}^{N} w_i R_i$	

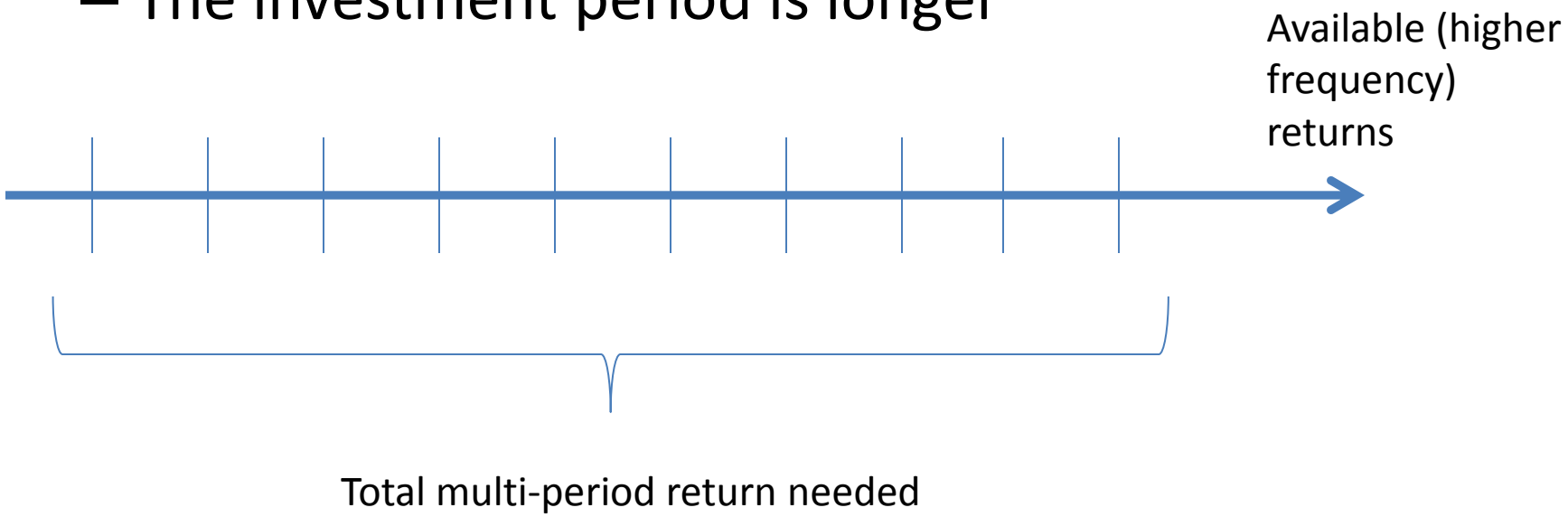
- Simple example with 2 assets

Video 4: The PerformanceAnalytics package and multiperiod returns

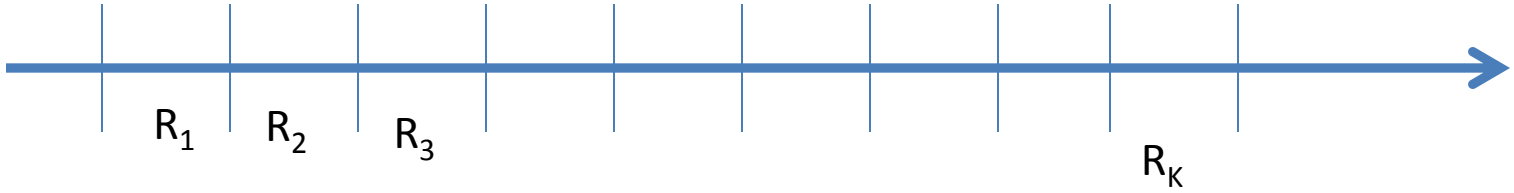
- We have seen single period returns of a portfolio with only a few investments
- In practice:
  - Multi-period investments
  - Larger portfolios
- Scalability is possible using the functionality of the R package PerformanceAnalytics
- Illustration for the 30 DJIA stocks over 25 years with monthly rebalancing

- First, multi-period returns

- A common mismatch:
  - Returns are available at a daily, weekly or monthly frequency
  - The investment period is longer



- Compounding formula



- Initial value: Vi
- Value after:
  - One period: $Vi(1+R_1)$
  - Two periods: $Vi(1+R_1)(1+R_2)$
  - …
  - K periods: $Vi(1+R_1)(1+R_2)…(1+R_K)$

Multiperiod return

- Initial value: Vi
- Value after K periods: $Vi(1+R_1)(1+R_2)\ldots(1+R_K)$

- Hence the k-period return:

$$R[k] = \frac{Vi(1+R_1)(1+R_2)\ldots(1+RK) - Vi}{Vi}$$

$$= (1+R_1)(1+R_2)\ldots(1+R_K) - 1$$

```
returns <- c( 0.05 , -0.01 , 0.03 , 0.02 , 0.01 )
cumprod(1+returns)
[1] 1.050000 1.039500 1.070685 1.092099 1.103020
tail(cumprod(1+returns),1)-1
[1] 0.1030197
```

- Let us now consider a realistic portfolio of stocks, invested in 30 large US firms, namely the stocks included in the Dow Jones Industrial Average universe:

[show tickers]

- For those thirty stocks, the variable ‘prices’ provides us the end-of-month close adjusted prices over the period December 1990 till December 2015

R Console

```
> head(prices,1)
                AA     AAPL      AXP       BA      BAC      CAT      CVX
1990-12-31 4.534478 1.345204 3.445906 13.77601 2.740819 3.259666 7.440307
                DD      DIS      GE       HD      HPQ     INTC      IBM
1990-12-31 7.68017 6.428398 2.35596 2.042869 1.004518 0.841387 18.27009
               JNJ      JPM       KO      MCD      MMM      MRK     MSFT
1990-12-31 5.103177 1.651136 3.398343 4.583788 10.70052 6.468881 0.723928
               NKE      PFE       PG      TRV      UTX       VZ      WMT
1990-12-31 1.024851 1.674406 5.991295 7.683583 3.471237 7.835626 5.455634
               XOM       T
1990-12-31 6.233811 4.64325
> tail(prices,1)
                AA     AAPL     AXP       BA     BAC      CAT      CVX
2015-12-31 9.827518 104.6919 68.9133 143.2643 16.7662 67.11964 88.83326
                DD    DIS       GE       HD      HPQ     INTC      IBM
2015-12-31 66.17163 105.08 30.90261 131.5268 11.70868 34.14943 136.2285
               JNJ      JPM       KO      MCD      MMM      MRK    MSFT
2015-12-31 101.9809 65.10796 42.62756 117.2517 149.5594 52.36191 55.0845
               NKE     PFE       PG      TRV      UTX       VZ      WMT
2015-12-31 62.33928 31.9587 78.72384 112.2365 95.35903 45.18148 60.84953
               XOM        T
2015-12-31 77.24887 33.51689
```

- Returns

R Console

Click or Press Ctrl+2 to focus

```
> returns <- CalculateReturns(prices,method="simple")
> head(returns)
                   AA        AAPL         AXP          BA         BAC
1990-12-31         NA          NA          NA          NA          NA
1991-01-31  0.128181899  0.29069717  0.10302951  0.08815424 0.22950841
1991-02-28 -0.003884696  0.03370538  0.05494594 -0.01808654 0.03999988
1991-03-31  0.021443165  0.18777315  0.20312426 -0.02590673 0.19835795
1991-04-30  0.037425309 -0.19117668 -0.12724754 -0.02659574 0.06498192
1991-05-31  0.053703048 -0.14326469  0.02500053  0.07676566 0.14237304
```

- Returns

```
> returns <- CalculateReturns(prices,method="simple")
> returns <- returns[(-1),]
> head(returns)
                    AA        AAPL         AXP          BA         BAC
1991-01-31  0.128181899  0.29069717  0.10302951  0.08815424  0.22950841
1991-02-28 -0.003884696  0.03370538  0.05494594 -0.01808654  0.03999988
1991-03-31  0.021443165  0.18777315  0.20312426 -0.02590673  0.19835795
1991-04-30  0.037425309 -0.19117668 -0.12724754 -0.02659574  0.06498192
1991-05-31  0.053703048 -0.14326469  0.02500053  0.07676566  0.14237304
1991-06-30 -0.050966017 -0.11702172 -0.11308280 -0.06632650 -0.14381507
```