INTRODUCTION TO KIU-FIM

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Introduction to FIM

- I will include topics on:
  - Business and Finance
  - Math
  - IT, computer science and AI
  - Communication skills
  - Ethics and professional behaviour
- I will do the most interactive parts while on location at KIU
  - I will leave the technical aspects for the online lectures
- There is a course website
- You are invited and **expected** to participate in classes
  - We will often conduct
    - Discussions
    - role-playing exercises

Discussion #1

Why are you here?

What are your:
- **Goals**
- **Ambitions**

The Math of Business

How do
Finance,
Information technology and
Management
work together

The Investment Fund Lifecycle

Conception: why?

Birth: how?

Growth: what?

Death: oh, no…!

The City

- The city of Montreal spends over one $100M each year cleaning snow

- The cleaning is done via public tender for a flat rate for selected months

- The monthly charge is costly, but snow cleaning outside the contract season is extremely **expensive**

Ski Resorts

Ski resorts have the opposite problem:
Snow outside the normal season provides a good gains
Late arrival of snow, or an early spring leads to substantial losses.

The snow swap

If there **no** snow,
the city pays the ski resort a fee:
$10M

If there **is** snow,
the ski resort pays the city a fee:
$10M

The city and the resort
-in the end-
did not agree on
where to measure
snow precipitation

The deal died 😩😩

Investments as Risk transfer

For $2M fee
(10% of the cashflows)

$10M payment
city dependent

$10M payment
ski resort dependent

The Snow Fund

Portfolio Cash flows

Assume correlation of 50% between city and resort precipitation. Then

with 75% probability, both swaps yield opposite flows, and we just collect our fee: $2M.

With 12.5% probability, we receive payments from both: $22M.

With 12.5% probability, we have to pay both: -$18M

Investment parameters:

Invested amount: $20M
Average return: 10%
Volatility: 50%

Sharpe ratio = 0.2

A bad deal

$$\begin{aligned}\sigma^2 &= 0.75 * 0^2 + 0.125 * 1.10^2 + 0.125 * 0.9^2 \\ &\approx 0.25\end{aligned}$$

A diversified fund

We do the same deal in
100 cities and ski resorts
in North America

Cashflows are independent of each other
(independent of global warming)

Blue Mountain (Toronto)
Mountain Creek (New Jersey)
Panorama Mountain Village (Calgary)
Snowshoe Mountain (West Virginia)
Steamboat Ski Resort (Hayden, Denver)
Stratton Mountain Resort (Vermont)
Tremblant (Montreal)
Whistler Blackcomb (Vancouver)
...

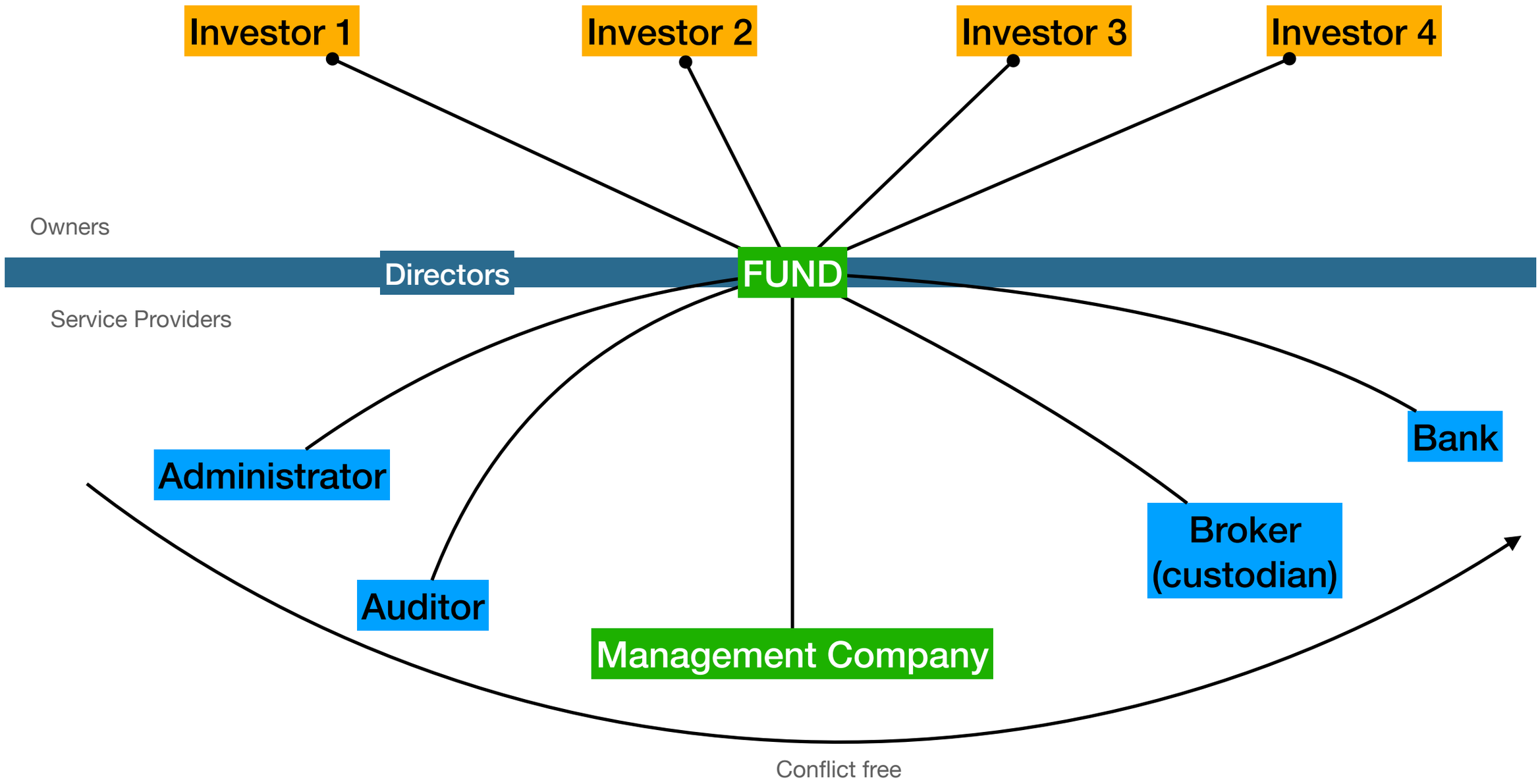
... and several others

Investment parameters:

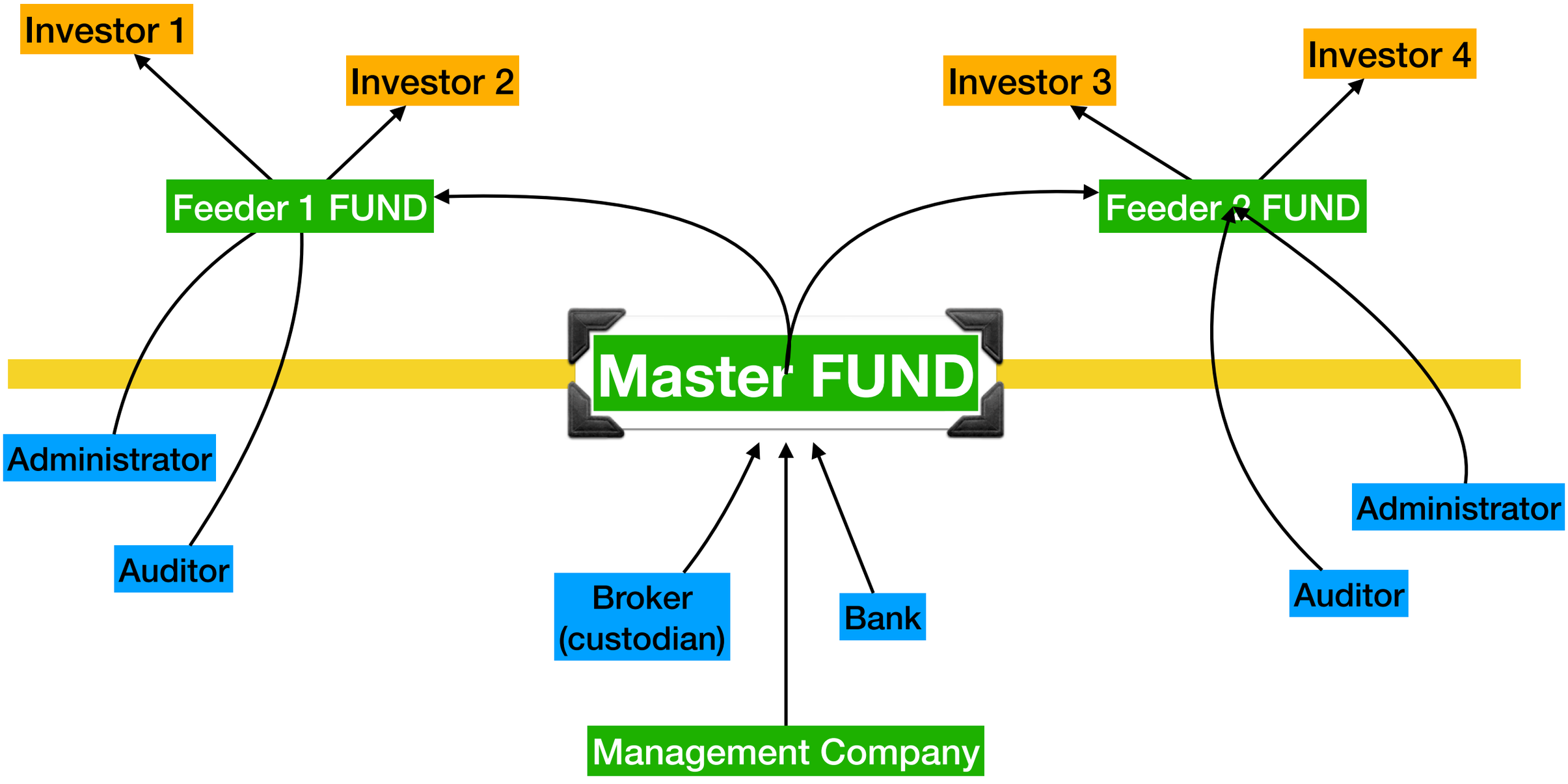
Invested amount: $2Bn
Average return: 10%
Volatility: 5%

Sharpe ratio = 2

A fund is born



The Master/Feeder structure



1-20 Fees

1% of assets
20% of net gains

	Investor	Manager
Invested amount	2000	0
Gross investment gains	200	0
Management fee	-20	+20
Performance fee	-36	+36
Total gains	**144**	**56**
Profitability	7.2%	Infinity

OM

The **Offering Memorandum** is a legally binding document that stipulates the basic conditions for the proper management of the fund, including:

- Portfolio and investment guidelines
- Fees
- Valuation principles and methodologies
- Liquidity provisions

Investors **must read** it and invest only if in agreement with the terms

Outflows: Liquidity risk

- Our snow fund is moving along nicely, when suddenly one of the investors wants to washout (redeem) their investment
- The fund will have to release collateral by negotiating swap break ups
- Swap break ups will lead to substantial losses, mostly in the form of penalties
- We could also try to sell the swaps to a third party, who will obviously pay heavily discounted values
- Either way, the fund will incur into substantial losses due to an early withdrawal of an investor
- Funds usually need to have liquidity of their share classes in line with the underlying securities of their portfolio

Growth

- Asset under management growth (AUM)
- Fees
- Capacity

Capacity

- Hedge fund capacity is the amount of AUM they can manage before performance will suffer:
- Example: in our snow fund, if only 100 swaps are available to be negotiated, capacity is $2Bn.
  - With less than $2Bn AUM, risk will rise but return continues at 10%
  - With more than $2Bn AUM, return will lower since additional funds cannot be invested and P&L will have to be shared amongst more investors.
- Capacity is an issue for funds operating in markets with limited inefficiencies, size or volumes.

Capacity

	Investor	Manager
Invested amount	4000	0
Gross investment gains	200	0
Management fee	-40	+40
Performance fee	-32	+32
Total gains	128	72
Profitability	3.2%	Infinity

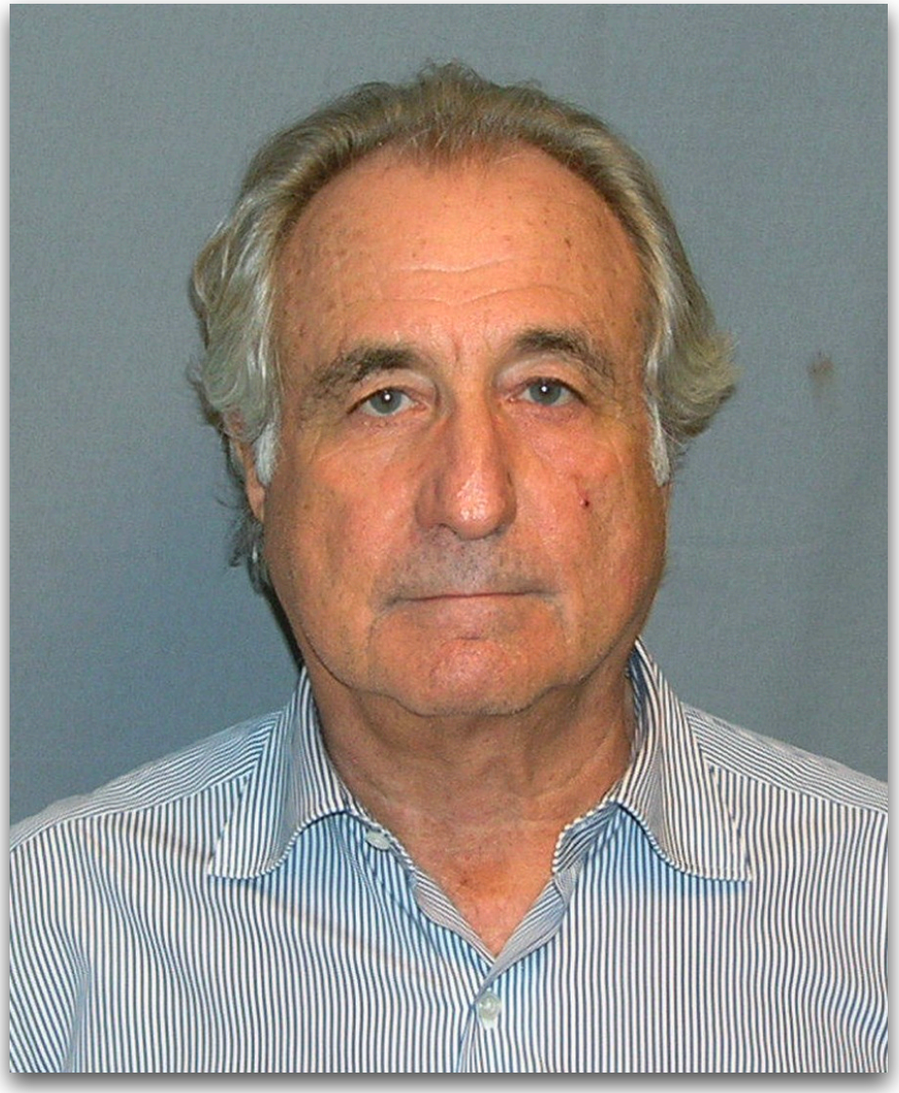
	Investor	Manager
Invested amount	2000	0
Gross investment gains	200	0
Management fee	-20	+20
Performance fee	-36	+36
Total gains	~~144~~	56
Profitability	7.2%	Infinity

Death

- Fraud
- Performance drag
- Blow-up
- Flows

Qualitative Risks: Madoff Case

- $65B “lost” to fraud
  - alleged to do non-existing trades
- Bernie Madoff managed the money
- Bernie Madoff was the broker
- The Admin company had Bernie Madoff as their only client
  - Two employees
  - Millions in revenue



Credit risk

Report on Business

Key dates and facts

How did Intrawest rack up so much debt?

Intrawest lenders said Wednesday they will move to auction off the ski resort company. How did this happen?

Tavia Grant

Globe and Mail Update Published on Thursday, Jan. 21, 2010 1:00PM EST Last updated on Thursday, Jan. 28, 2010 2:21PM EST

Dec. 24, 2009

- Debt is in default and declared due. "Given the lack of progress on restructuring talks, the lenders determined there was no alternative to exercising their remedies as secured creditors."

Blue Mountain (Toronto)
Mountain Creek (New Jersey)
Panorama Mountain Village (Calgary)
Snowshoe Mountain (West Virginia)
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...

... and several others

	Investor	Manager
Invested amount	2000	0
Gross investment gains	-60	0
Management fee	-20	+20
Performance fee	0	0
Total gains	-80	20
Profitability	-4%	Infinity

Risk taxonomy

- Market
  - Loss of NAV due to changes in asset prices
- Credit
  - Loss of NAV due to default events
- Liquidity
  - Example: LTCM
- Gap risk
  - The risk that an investment's price will change from one level to another with no trading in between
- Legal Risk
  - Example: Bankers Trust
- Operational risk
  - Fat fingers, fraud, etc.

Speculation vs. arbitrage

- You cannot obtain returns without taking risks
- Risks can often be mitigated by:
  - hedging
  - diversification
- Investment opportunities exist with “lower-than-normal risks”: **arbitrage**
- Market inefficiencies are a source of “arbitrage”
- Hedge Funds are investment vehicles designed to take advantage of:
  - arbitrage (in general terms)
  - market inefficiencies (a type of arbitrage)
  - risk mitigation strategies through hedging or diversification

Collateral

How much money do we need for a contract?

- Usually, counter parties want cash or securities as collateral for future payments:

  - Example: a mortgage, the house is a collateral against future payments; if payments do not occur, the bank keeps the house.

- This allows an indirect “borrowing” to take place, as one can act as if you have money when you don’t.

Leverage

How much money do we need for the snow fund?

Depends on our counter parties

- Case 1: $20M per swap, $2Bn total

No trust or negotiating power

- Case 2: $20 x M per swap, $2xBn total (0<x<1)

Some trust or negotiating power

  - Possible if a bank lends us the difference

  - Or the city & ski resort sign the swap without full **collateral**

- Case 3: Can we do the swap with $0?

Ignorant counter parties

Exercises

Investments

Leverage-Credit Rating

In the Snow Fund, assume the fund can enter into a $1M swap with a funding ratio of x (collateral of $2xM.)

- Determine the fund financials with leverage
- Determine the Exposure, Probability of Default and Loss-Given-Default.
- What is the fund credit rating?

Risk enhancement

- Consider different collateral arrangements and determine how they change the risk profile of the fund
  - Lower collateral requirements for the fund results in higher return
  - Higher collateral requirements for the city/resort result in lower credit risk profiles
- How would you blend the risk and return results of the previous steps?

Portfolio Return

return

$$r_k = \frac{S_k - S_{k-1}}{S_{k-1}},$$

log-return

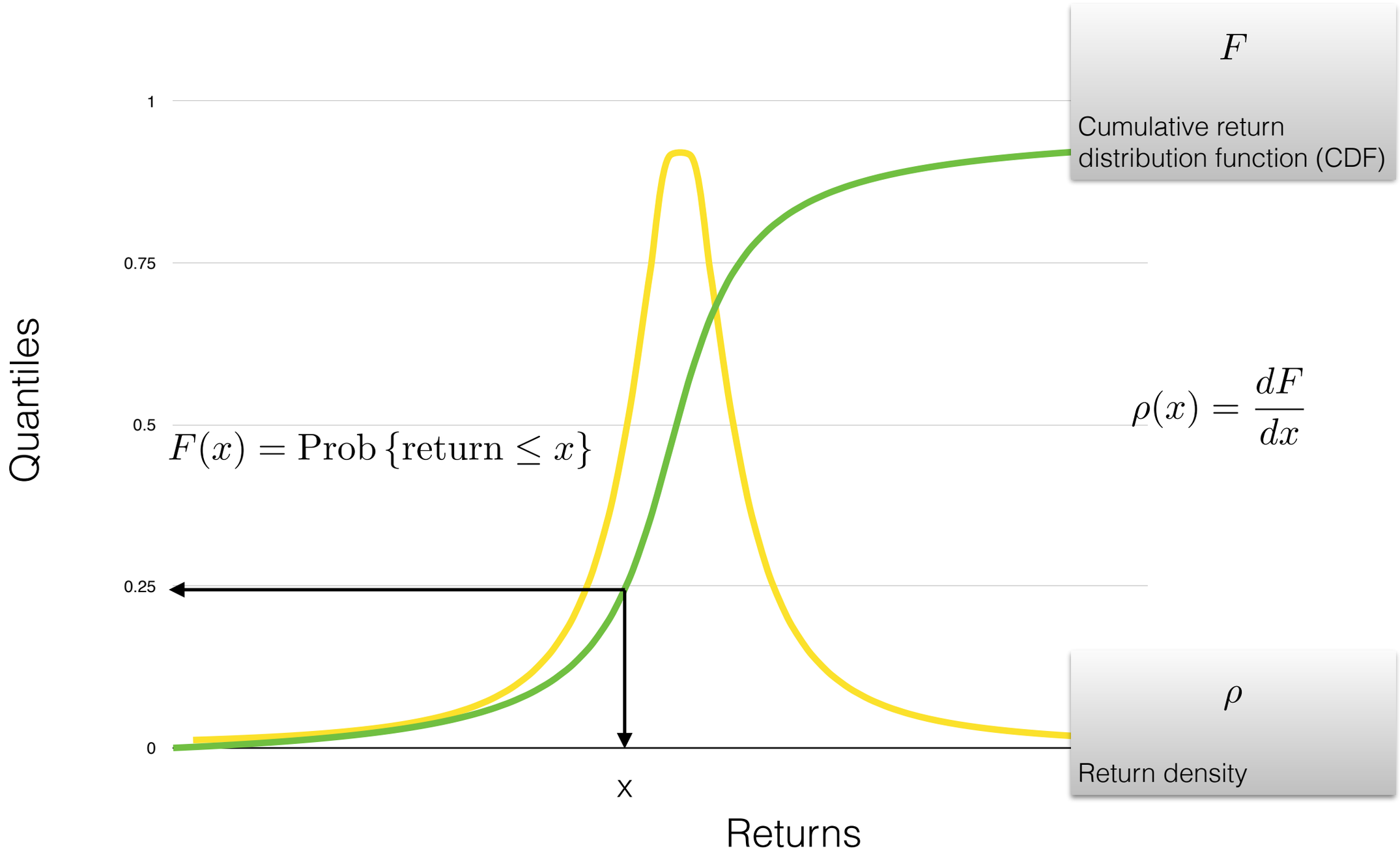
$$r_k^{\log} = \log \frac{S_k}{S_{k-1}} = \log(1 + r_k).$$

Share value

In either case, we can collect a time series of portfolio returns

Daily
Monthly

Portfolio Stats



Portfolio statistics

Heaven

$$\mu = \int_{-\infty}^{\infty} x\rho(x)\,dx$$
$$= \mathbb{E}(X)$$
$$\sigma^2 = \int_{-\infty}^{\infty} (x-\mu)^2\rho(x)\,dx$$
$$= \mathbb{E}(X-\mu)^2$$

Earth

Average return, mean return

$$\overline{r} = \frac{1}{n}\sum_{i=1}^{n} r_i$$

return

months (or days)

Volatility, standard deviation

$$\sigma = \sqrt{\frac{1}{n-1}\sum_{i=1}^{n}(r_i - \overline{r})^2}$$

Careful with Statistics

	Fund balance	Simple Return	Logarithmic return
January	$1		0.00%
February	$2	100%	69.31%
March	$1	-50%	-69.31%
April	$2	100%	69.31%
May	$1	-50%	-69.31%
June	$2	100%	69.31%
July	$1	-50%	-69.31%
August	$2	100%	69.31%
September	$1	-50%	-69.31%
October	$2	100%	69.31%
November	$1	-50%	-69.31%
December	$2	100%	69.31%
Average return		25%	0
Standard Deviation		75%	70%

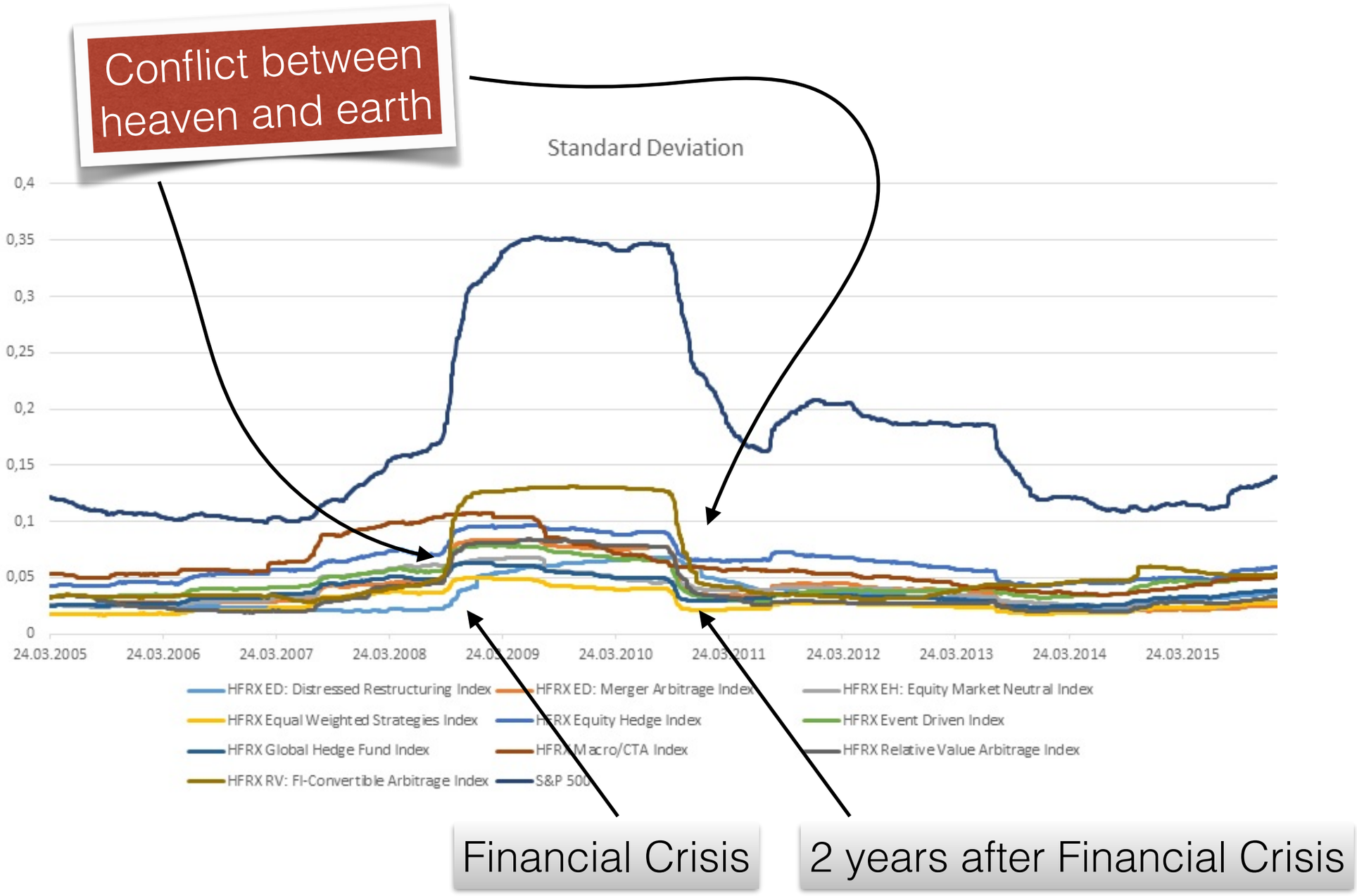
Running mean

2 year window runs ahead daily

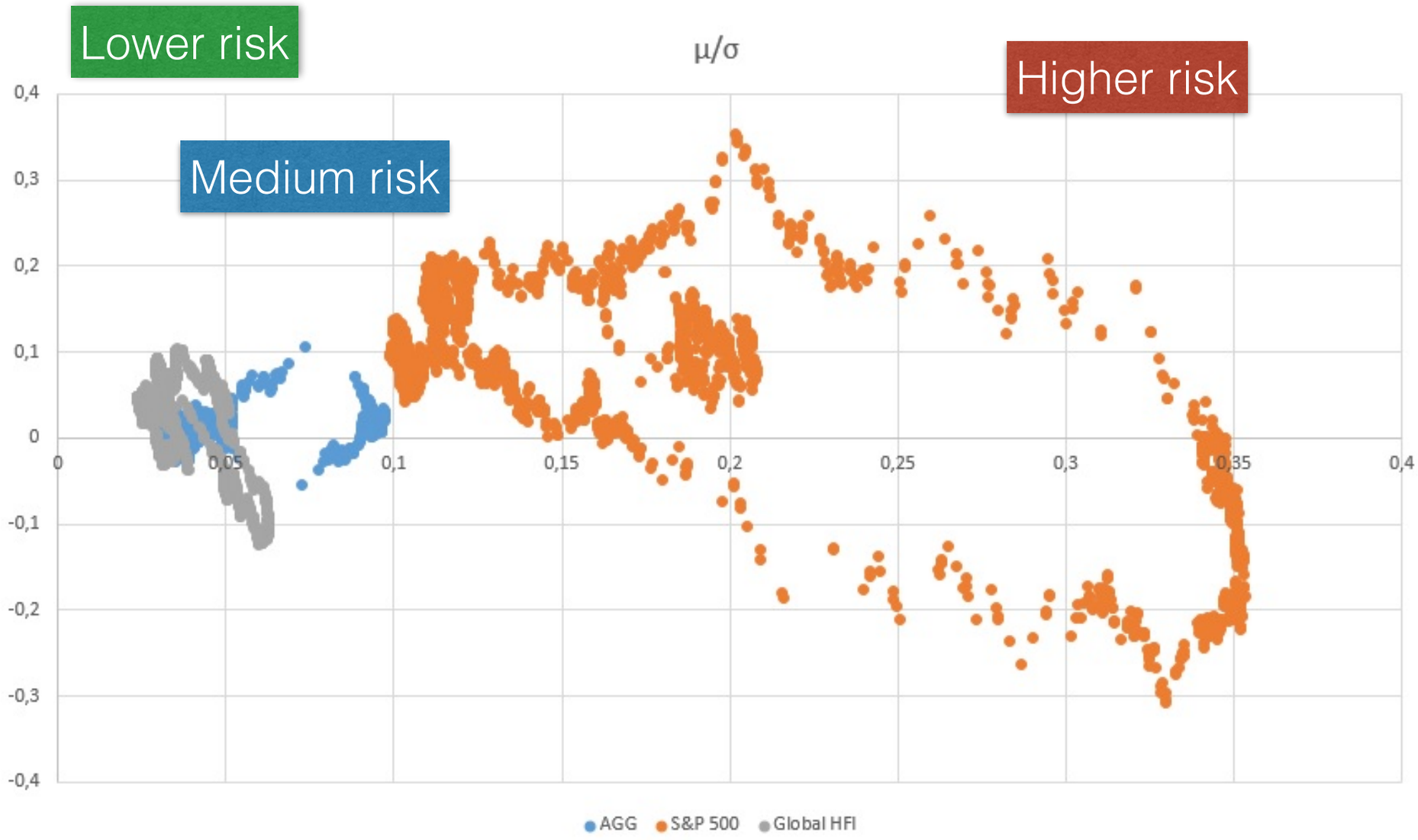
Mean of the prior 2 year time window

Conflict between heaven and earth

Running standard deviation



Averages over time



Returns over time

Time-Weighted-Rate-of-Return

- Monthly returns can be compounded over time

- Time-weighted rate of return, over n periods, is defined as

$$1 + R = (1 + r_1)(1 + r_2) \cdots (1 + r_n)$$

Time weighted returns

	Fund balance	Inflows	P&L	Monthly Return	Cummulative return
January	$1	$1	$1	100%	100%
February	$2	$0	$2	100%	300%
March	$4	$0	$4	100%	700%
April	$8	$0	$8	100%	1500%
May	$16	$0	$16	100%	3100%
June	$32	$0	$32	100%	6300%
July	$64	$0	$64	100%	12700%
August	$128	$0	$128	100%	25500%
September	$256	$0	$256	100%	51100%
October	$512	$0	$512	100%	102300%
November	$1,024	$0	$1,024	100%	204700%
December	$1,000,002,048	$1,000,000,000	-$500,001,024	-50%	102300%
January	$500,001,024	$0			

Time weighted rate of return

Returns over time

Time-Weighted-Rate-of-Return

- Monthly returns can be compounded over time
- Time-weighted rate of return, over n periods, is defined as

$$1 + R = (1 + r_1)(1 + r_2) \cdots (1 + r_n)$$

Internal-Rate-of-Return

- Takes into account the amounts invested over time

If we make

- investments worth p_k
- at time t_k ago
- and the final value of the fund is V,
- the Internal Rate of Return is defined implicitly by the expression

$$V = \sum_k p_k (1 + R)^{t_k}$$

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November	$1,024	$0	$1,024	100%	204700%
December	$1,000,002,048	$1,000,000,000	-$500,001,024	-50%	102300%
January	$500,001,024	$0			

Time weighted rate of return

Internal rate of return

$$500{,}001{,}024 = 1 \cdot (1+R)^{11/12} + 1{,}000{,}000{,}000 \cdot (1+R)^{1/12}$$

$$R \approx -50\,\%$$

Correlation

For two funds, with monthly returns given by random variables X and Y, the **covariance** is obtained as

$$\mathrm{Cov}(X,Y) = \mathbb{E}(X - \mathbb{E}(X))(Y - \mathbb{E}(Y)) \longleftarrow \text{Heaven}$$

$$= \frac{1}{n-1}\sum_{i=1}^{n}\left(X_i - \overline{X}\right)\left(Y_i - \overline{Y}\right) \longleftarrow \text{Earth}$$

and the correlation

$$\rho(X,Y) = \frac{\mathrm{Cov}(X,Y)}{\sigma_X \cdot \sigma_Y}$$

By the Cauchy-Schwartz inequality,

$$-1 \leq \rho \leq 1.$$

Portfolio volatility

Consider a portfolio Π that allocates w_i to assets with returns given by random variables X_i, $i = 1, \ldots, n$.
If the covariance matrix of X_i is given by $V = (\sigma_{i,j})$, the portfolio volatility is

$$\begin{aligned}
\sigma_\Pi^2 &= \left\langle \sum_{i=1}^{n} w_i \cdot X_i \, , \, \sum_{j=1}^{n} w_i \cdot X_j \right\rangle \\
&= \sum_{i,j} w_i \, w_j \, \langle X_i \, , \, X_j \rangle \\
&= \boxed{\sum_{i,j} w_i \, w_j \, \sigma_{i,j}} \\
&= w \cdot V \cdot w^T .
\end{aligned}$$

Implies portfolio diversification:

When correlations are less then 1 or even negative

portfolio volatility decreases

Therefore,

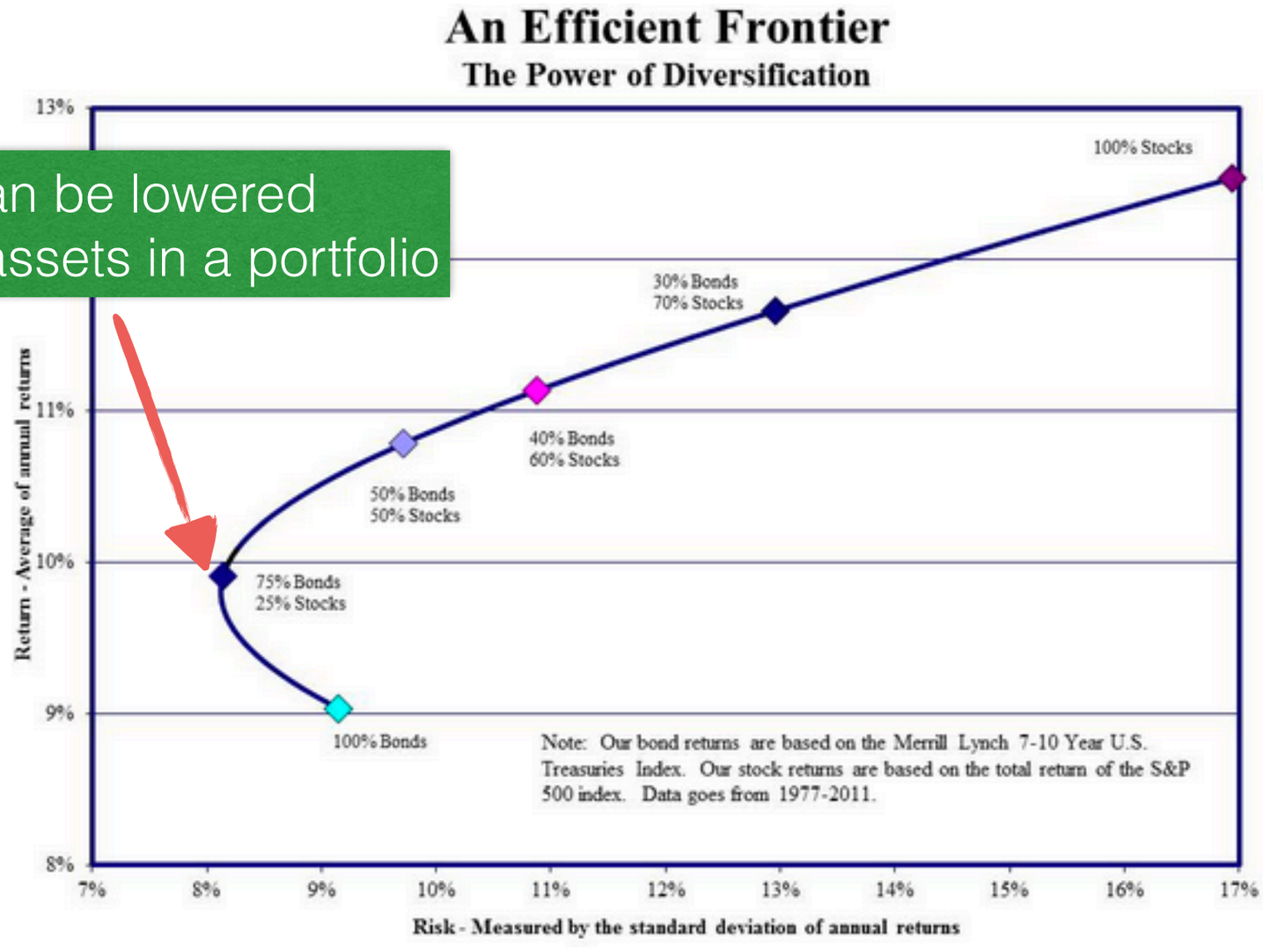
$$\sigma_\Pi = \sqrt{\qquad\qquad}$$

Portfolio risk and return

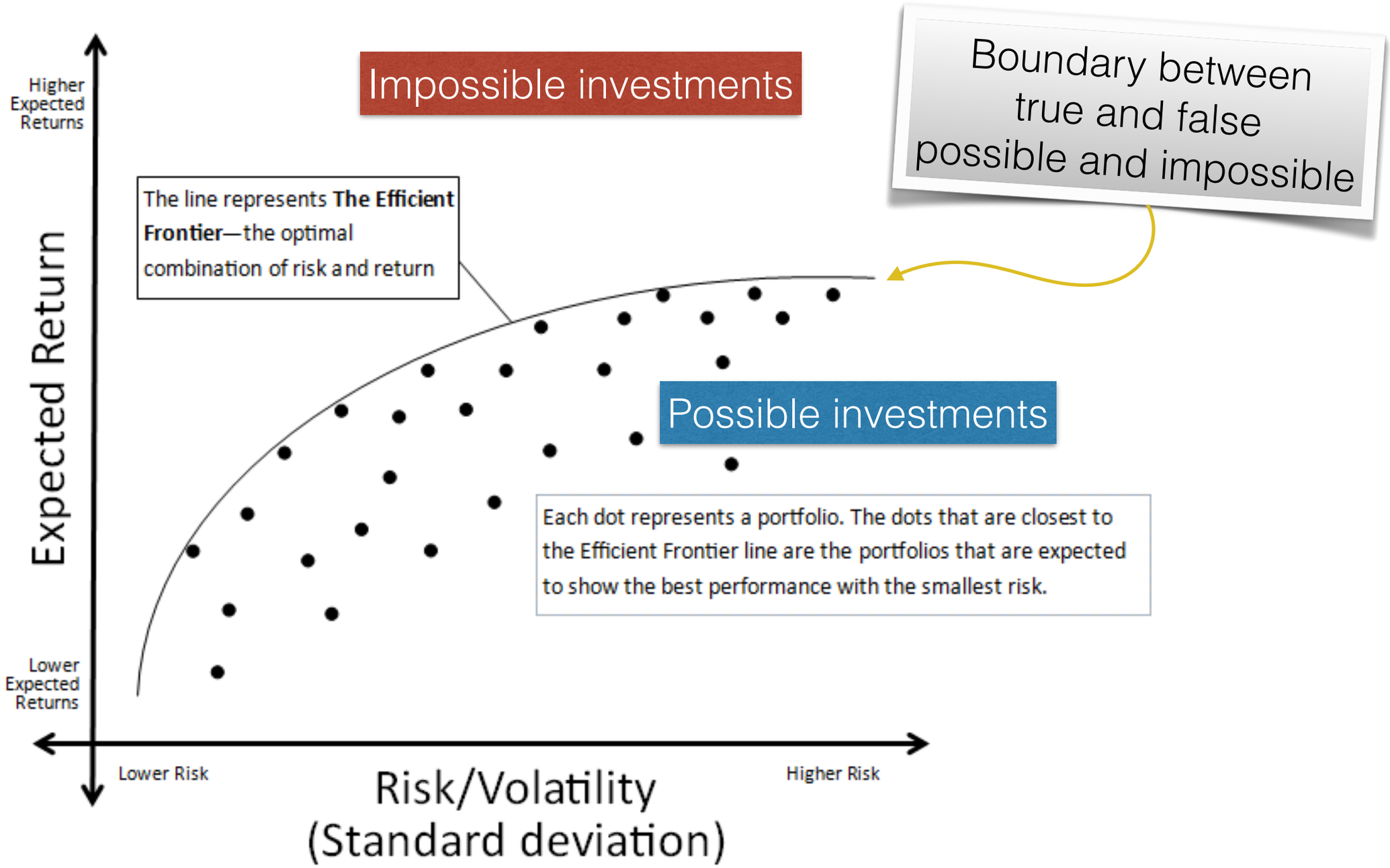
- Markowitz proposed, in 1952, that portfolios are characterized by two parameters:
  - Their expected return
  - Their standard deviation
- In this framework, portfolio selection is reduced to picking points in a risk–return plane

Portfolio Diversification

Risk can be lowered combining assets in a portfolio

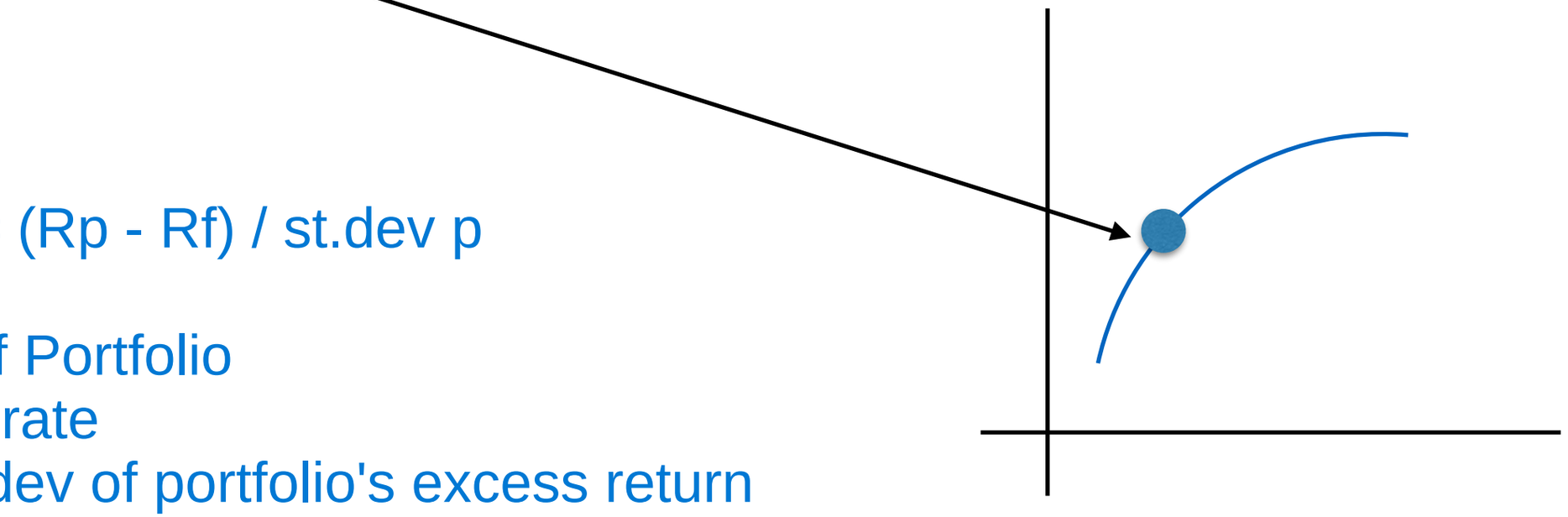


Efficient Frontier



Sharpe Ratio

- Markowitz argues that we should invest in the efficient frontier, but does not specify where
- Sharpe tells us where in the frontier we should invest:



Sharpe Ratio = (Rp - Rf) / st.dev p

Rp --> return of Portfolio
Rf --> risk-free rate
st.dev p --> st.dev of portfolio's excess return

An employment contract

A portfolio manager will be paid a $1M bonus if it makes a benchmark return of r.

We seek a portfolio Π that maximizes the probability of exceeding a fixed benchmark r.

If returns are normally distributed:

$$\text{Prob}\{\Pi \geq r\} = \text{Prob}\left\{\frac{\Pi - \mu}{\sigma} \geq \frac{r - \mu}{\sigma}\right\}$$

$$= 1 - \phi\left(\frac{r - \mu}{\sigma}\right)$$

Independent of the portfolio: Normal (0,1)

Cumulative distribution of the Gaussian

The rational decision is to maximize the Sharpe Ratio with benchmark *r*

$$\frac{\mu - r}{\sigma}$$

Another employment contract

A portfolio manager will be paid a $1M bonus if it makes a benchmark return of r **ABOVE an index Y**

We seek a portfolio Π that maximizes the probability of exceeding a known, but random, benchmark $Y + r$.
If returns are normally distributed:

$$\begin{aligned}\text{Prob}\{\Pi \geq Y + r\} &= \text{Prob}\{(\Pi - Y) \geq r\} \\ &= \text{Prob}\left\{\frac{\Pi - Y - (\mu_\Pi - \mu_Y)}{\sigma_{\Pi-Y}} \geq \frac{r - \mu_{\Pi-Y}}{\sigma_{\Pi-Y}}\right\} \\ &= 1 - \phi\left(\frac{r - \mu_{\Pi-Y}}{\sigma_{\Pi-Y}}\right)\end{aligned}$$

Independent of the portfolio: Normal (0,1)

Cumulative distribution of the Gaussian

The rational decision is to maximize the Information Ratio with benchmark *r*

$$\frac{\mu_\Pi - \mu_Y - r}{\sigma_{\Pi-Y}}$$

Tracking error

Köszönöm

תודה

Спасибі

Thanks

ありがとう

Gracias

ευχαριστώ

감사해요

cảm ơn

Kösz

Dankon

Teşekkürler

Danke

متشكرم

Merci

Grazie

tack

rahmat

Takk

谢谢

ਧੰਨਵਾਦ

Gratias

dzięki

спасибо

धन्यवादा

ขอบใจ

شكرًا

asante

dankie

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