

Mean-Variance criterion

# Preferences for outcomes

# Preferences for outcomes

- ▶ In finance it is common to express outcomes in terms of **returns** on the initial investment

# Preferences for outcomes

- ▶ In finance it is common to express outcomes in terms of returns on the initial investment and associated risks as **risks in the return**

# Preferences for outcomes

- ▶ In finance it is common to express outcomes in terms of returns on the initial investment and associated risks as risks in the return
- ▶ Individuals will prefer **higher expected returns** to lower expected returns, *ceteris paribus*

# Preferences for outcomes

- ▶ In finance it is common to express outcomes in terms of returns on the initial investment and associated risks as risks in the return
- ▶ Individuals will prefer higher expected returns to lower expected returns, *ceteris paribus*
- ▶ Individuals will prefer **lower risks** to higher risks, *ceteris paribus*

# Preferences for outcomes

- ▶ In finance it is common to express outcomes in terms of returns on the initial investment and associated risks as risks in the return
- ▶ Individuals will prefer higher expected returns to lower expected returns, *ceteris paribus*
- ▶ Individuals will prefer lower risks to higher risks, *ceteris paribus*
- ▶ Based on these two criteria we can **compare choices** and exclude many cases

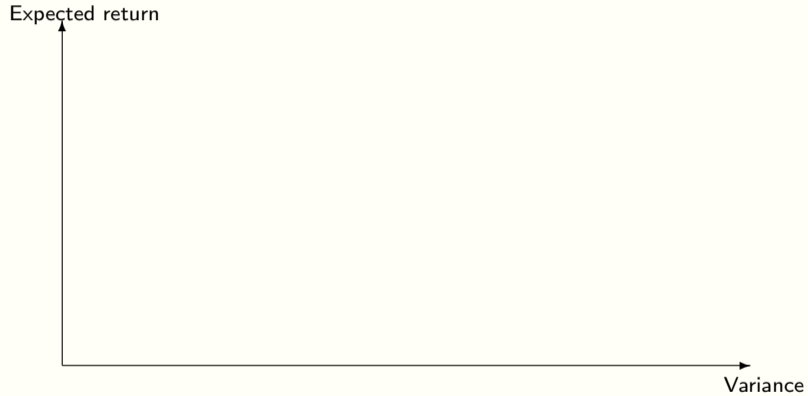
# Preferences for outcomes

- ▶ In finance it is common to express outcomes in terms of returns on the initial investment and associated risks as risks in the return
- ▶ Individuals will prefer higher expected returns to lower expected returns, *ceteris paribus*
- ▶ Individuals will prefer lower risks to higher risks, *ceteris paribus*
- ▶ Based on these two criteria we can compare choices and exclude many cases

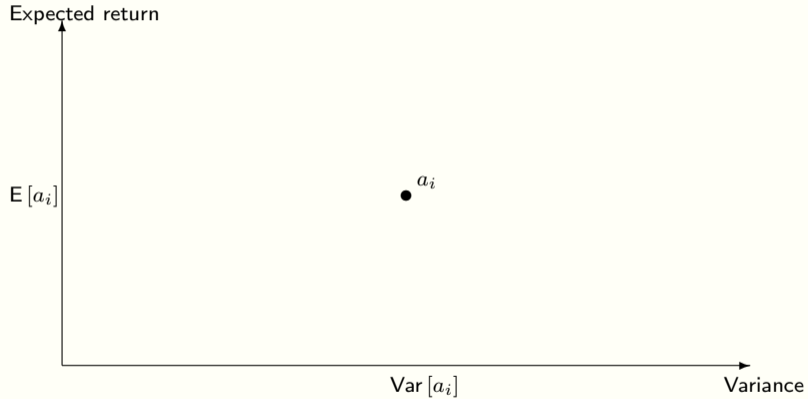


# Choice between two alternatives

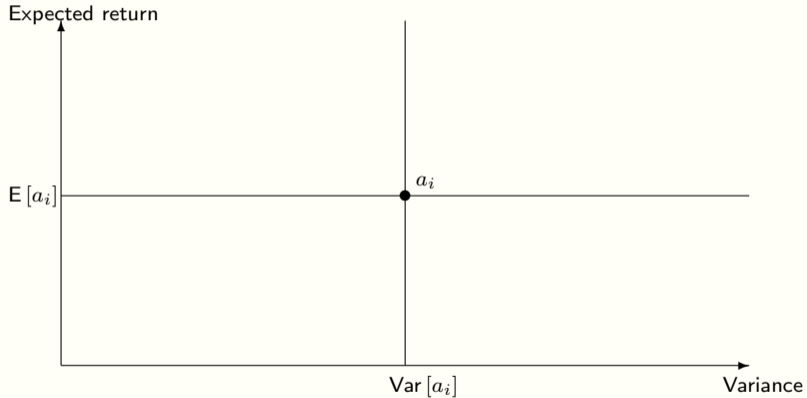
# Choice between two alternatives



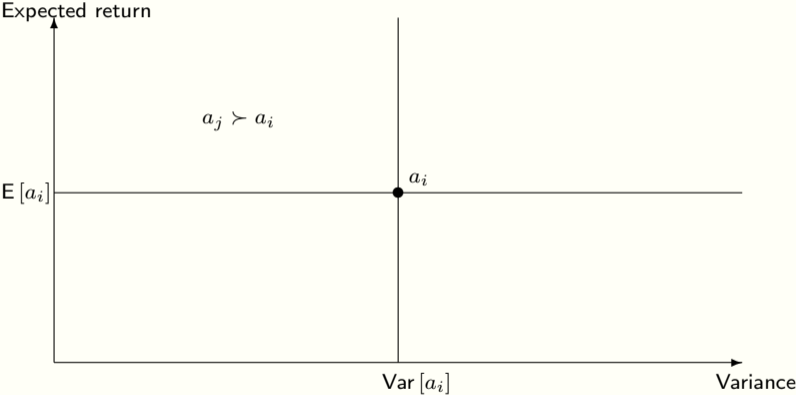
# Choice between two alternatives



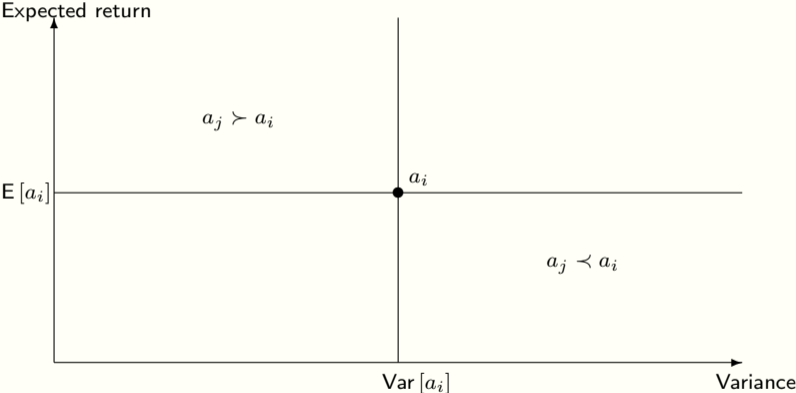
# Choice between two alternatives



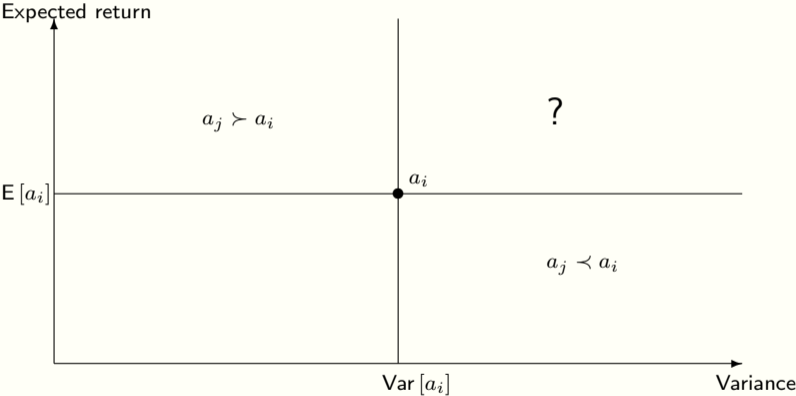
# Choice between two alternatives



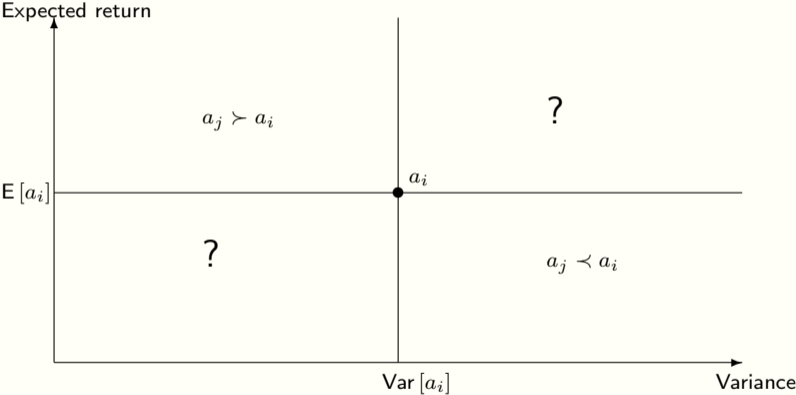
# Choice between two alternatives



# Choice between two alternatives

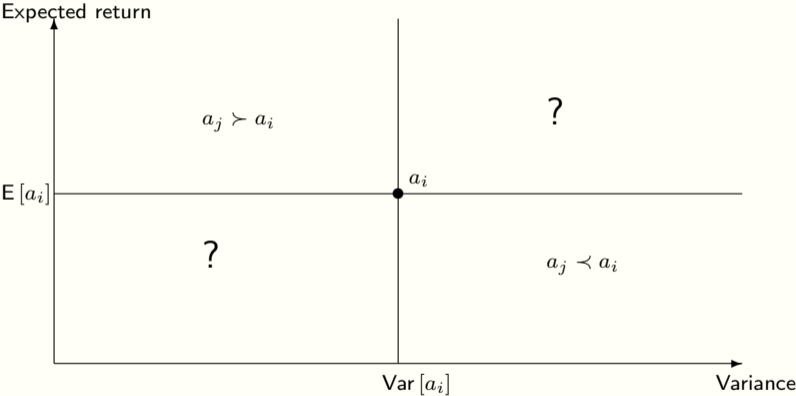


# Choice between two alternatives





# Choice between two alternatives



# Determining possible choices

# Determining possible choices

- ▶ By comparing any two alternatives, we can eliminate alternatives that have **higher risk and lower return**

# Determining possible choices

- ▶ By comparing any two alternatives, we can eliminate alternatives that have higher risk and lower return (**lower right**)

# Determining possible choices

- ▶ By comparing any two alternatives, we can eliminate alternatives that have higher risk and lower return (lower right)
- ▶ We cannot make a choice if the alternative has **higher risks and higher returns**

# Determining possible choices

- ▶ By comparing any two alternatives, we can eliminate alternatives that have higher risk and lower return (lower right)
- ▶ We cannot make a choice if the alternative has higher risks and higher returns (upper right)

# Determining possible choices

- ▶ By comparing any two alternatives, we can eliminate alternatives that have higher risk and lower return (lower right)
- ▶ We cannot make a choice if the alternative has higher risks and higher returns (upper right)
- ▶ We cannot make a choice if the alternative has **lower risks and lower returns**

# Determining possible choices

- ▶ By comparing any two alternatives, we can eliminate alternatives that have higher risk and lower return (lower right)
- ▶ We cannot make a choice if the alternative has higher risks and higher returns (upper right)
- ▶ We cannot make a choice if the alternative has lower risks and lower returns (lower left)



# Determining possible choices

- ▶ By comparing any two alternatives, we can eliminate alternatives that have higher risk and lower return (lower right)
- ▶ We cannot make a choice if the alternative has higher risks and higher returns (upper right)
- ▶ We cannot make a choice if the alternative has lower risks and lower returns (lower left)
- ▶ The best choices have no alternatives with **lower risks and higher returns**

## Determining possible choices

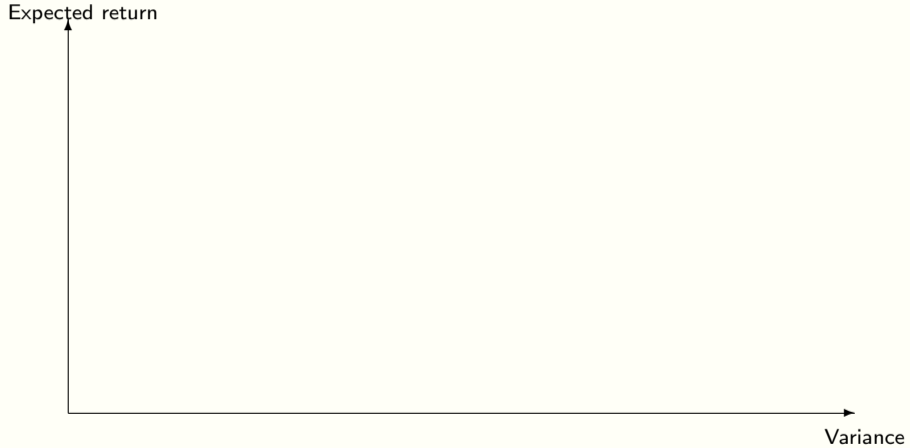
- ▶ By comparing any two alternatives, we can eliminate alternatives that have higher risk and lower return (lower right)
- ▶ We cannot make a choice if the alternative has higher risks and higher returns (upper right)
- ▶ We cannot make a choice if the alternative has lower risks and lower returns (lower left)
- ▶ The best choices have no alternatives with lower risks and higher returns (upper right)

## Determining possible choices

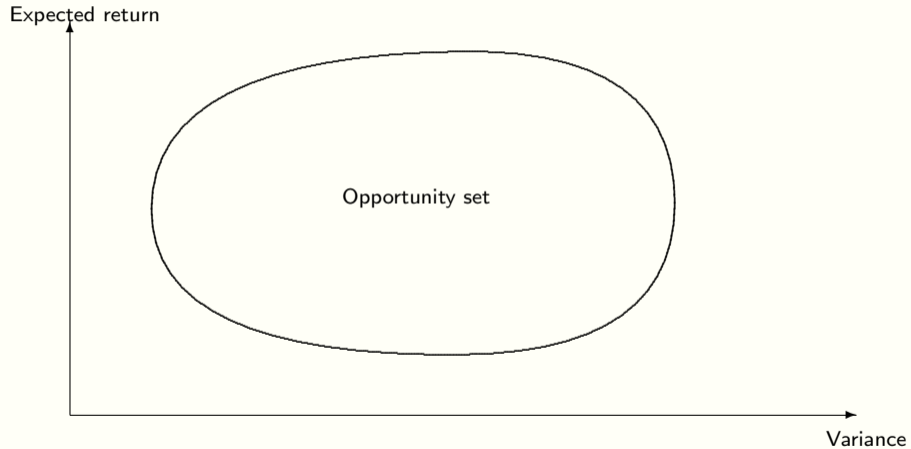
- ▶ By comparing any two alternatives, we can eliminate alternatives that have higher risk and lower return (lower right)
- ▶ We cannot make a choice if the alternative has higher risks and higher returns (upper right)
- ▶ We cannot make a choice if the alternative has lower risks and lower returns (lower left)
- ▶ The best choices have no alternatives with lower risks and higher returns (upper right)

# The efficient frontier

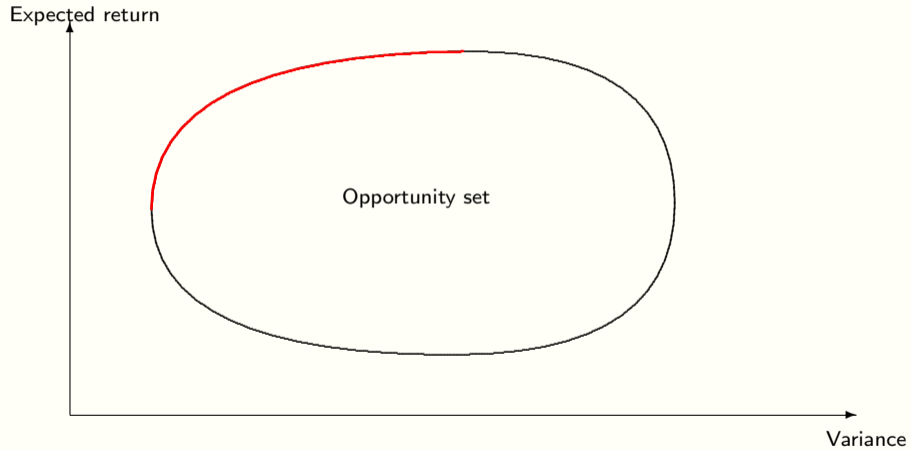
# The efficient frontier



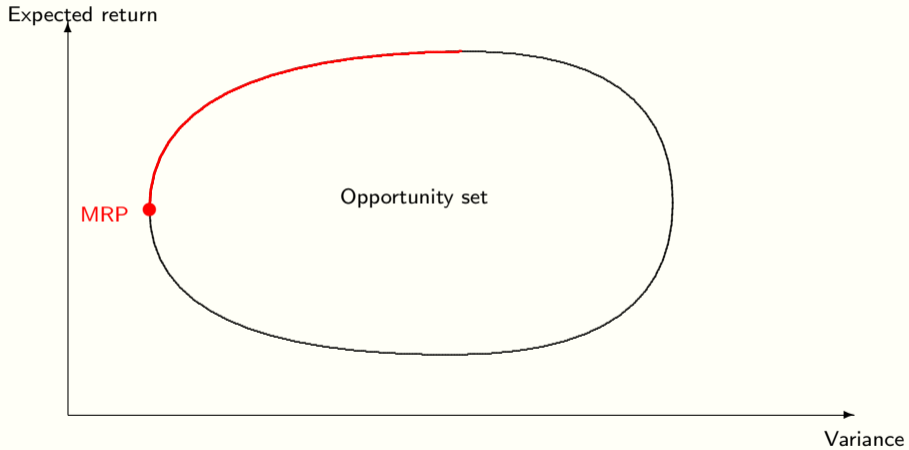
# The efficient frontier



# The efficient frontier

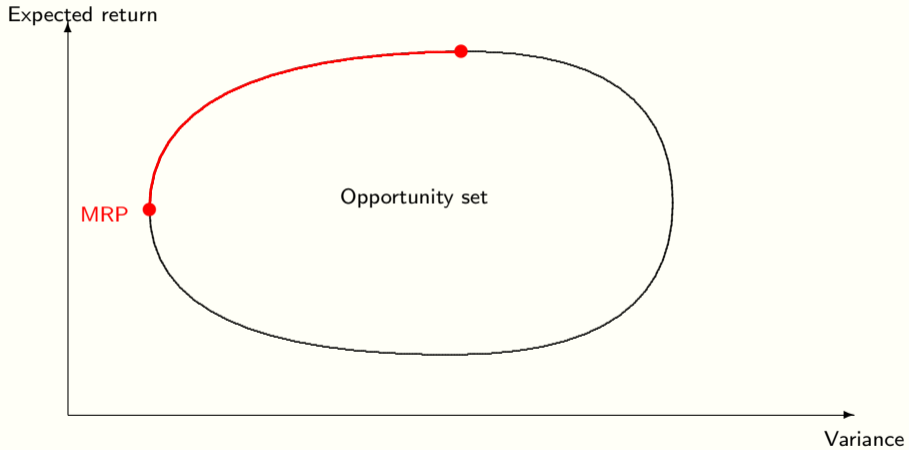


# The efficient frontier

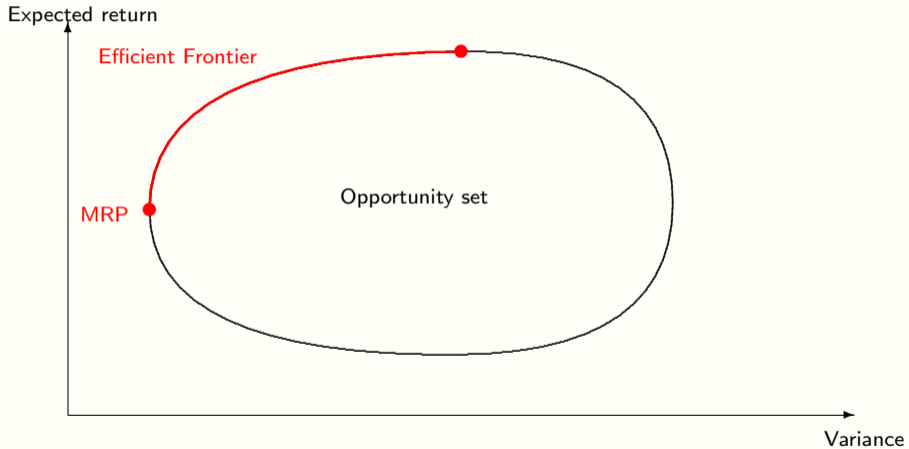




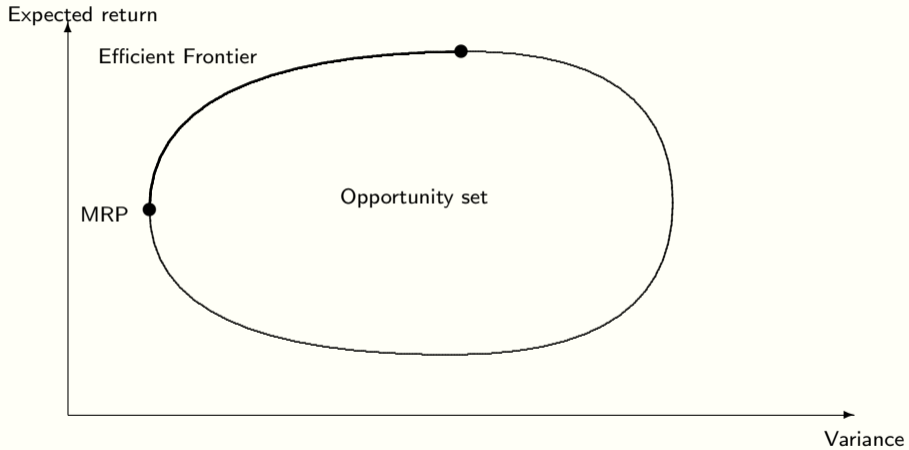
# The efficient frontier



# The efficient frontier



# The efficient frontier



# Selecting the best choice

# Selecting the best choice

- ▶ The **efficient frontier** resembles all possible choices that do not have an alternative with lower risks and higher returns (upper right)

## Selecting the best choice

- ▶ The efficient frontier resembles all possible choices that do not have an alternative with lower risks and higher returns (upper right)
- ▶ So far we only assumed that individuals are **risk averse**

## Selecting the best choice

- ▶ The efficient frontier resembles all possible choices that do not have an alternative with lower risks and higher returns (upper right)
- ▶ So far we only assumed that individuals are risk averse
- ▶ The specific utility function or the level of risk aversion was **not required**

# Selecting the best choice

- ▶ The efficient frontier resembles all possible choices that do not have an alternative with lower risks and higher returns (upper right)
- ▶ So far we only assumed that individuals are risk averse
- ▶ The specific utility function or the level of risk aversion was not required
- ▶ The **optimal choice** will be on the efficient frontier



# Selecting the best choice

- ▶ The efficient frontier resembles all possible choices that do not have an alternative with lower risks and higher returns (upper right)
- ▶ So far we only assumed that individuals are risk averse
- ▶ The specific utility function or the level of risk aversion was not required
- ▶ The optimal choice will be on the efficient frontier, but the **utility function** is needed to select it

# Selecting the best choice

- ▶ The efficient frontier resembles all possible choices that do not have an alternative with lower risks and higher returns (upper right)
- ▶ So far we only assumed that individuals are risk averse
- ▶ The specific utility function or the level of risk aversion was not required
- ▶ The optimal choice will be on the efficient frontier, but the utility function is needed to select it

# Indifference curves

# Indifference curves

- ▶ To compensate for **higher risks**, individuals require a **higher return**

# Indifference curves

- ▶ To compensate for higher risks, individuals require a higher return
- ⇒ Indifference curves have a **positive slope** as risk with risk aversion

# Indifference curves

- ▶ To compensate for higher risks, individuals require a higher return
- ⇒ Indifference curves have a positive slope as risk with risk aversion
- ▶ A higher risk aversion implies that individuals require **more compensation** when taking on additional risk

# Indifference curves

- ▶ To compensate for higher risks, individuals require a higher return
- ⇒ Indifference curves have a positive slope as risk with risk aversion
- ▶ A higher risk aversion implies that individuals require more compensation when taking on additional risk
- ⇒ Indifference curves have a **higher slope** the more risk averse an individual is

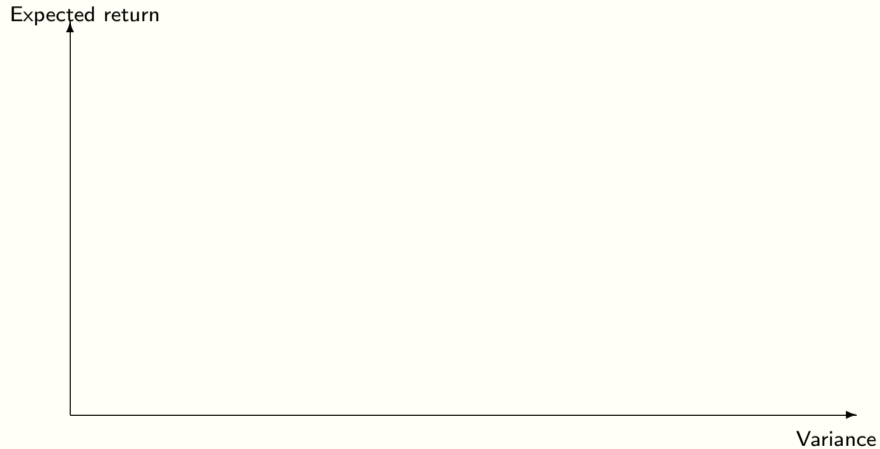
# Indifference curves

- ▶ To compensate for higher risks, individuals require a higher return
- ⇒ Indifference curves have a positive slope as risk with risk aversion
- ▶ A higher risk aversion implies that individuals require more compensation when taking on additional risk
- ⇒ Indifference curves have a higher slope the more risk averse an individual is

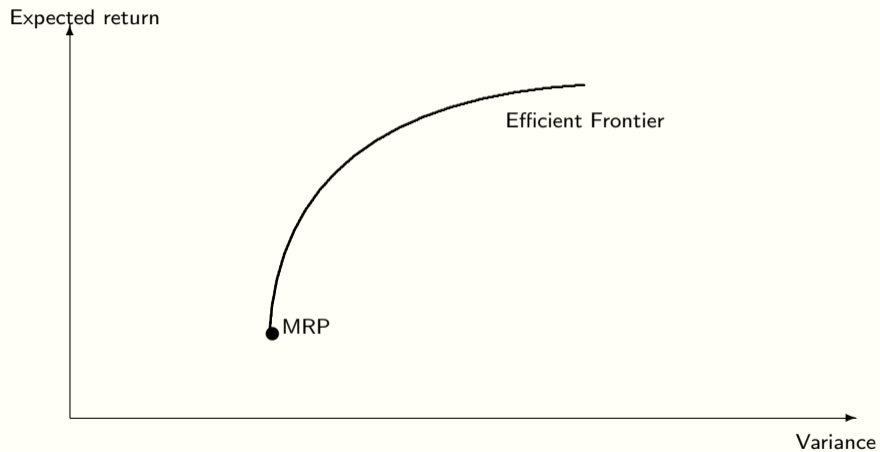


# Determination of the optimal choice

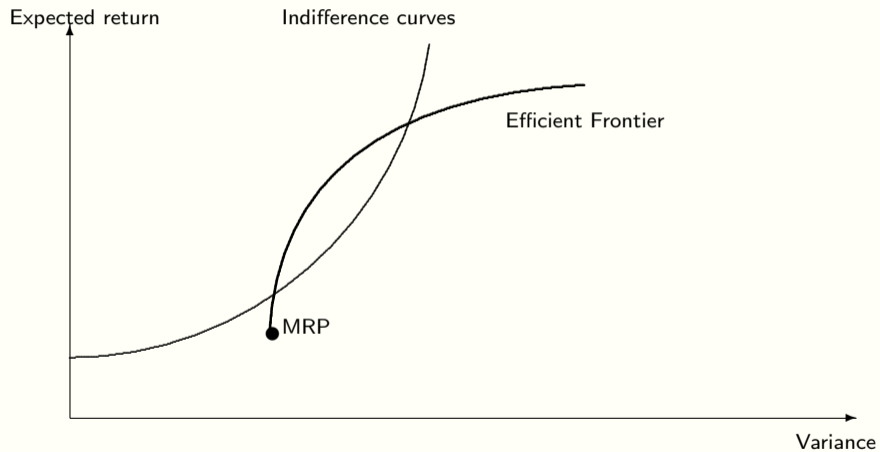
# Determination of the optimal choice



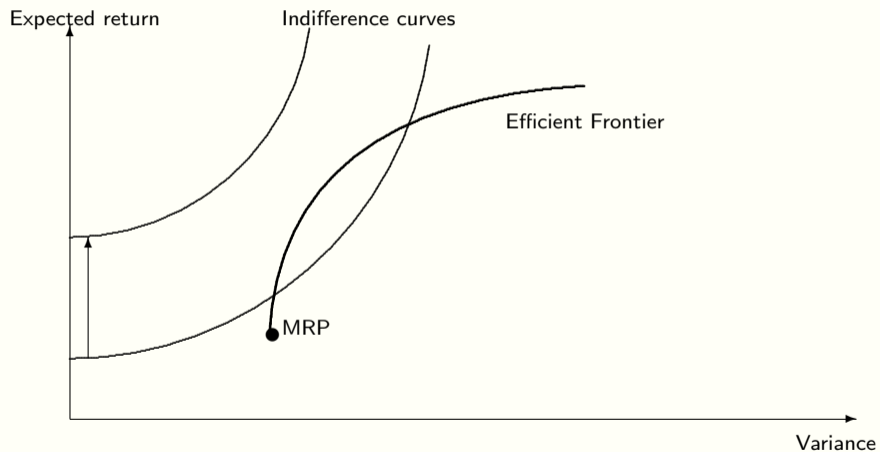
# Determination of the optimal choice



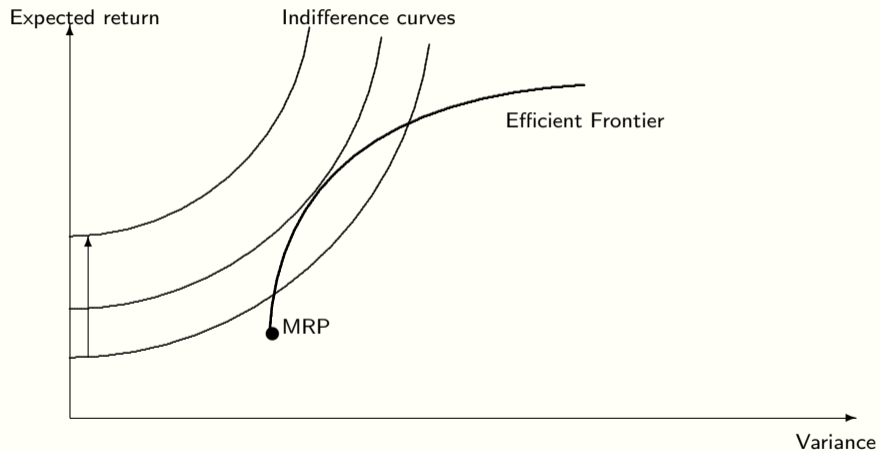
# Determination of the optimal choice



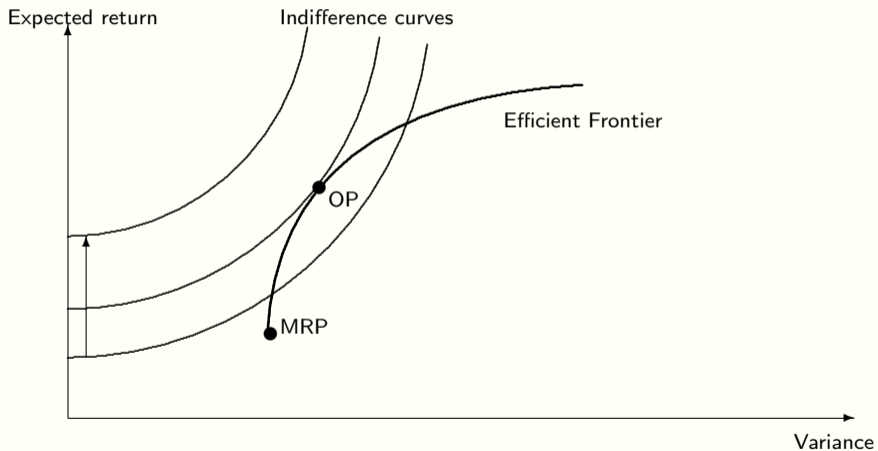
# Determination of the optimal choice



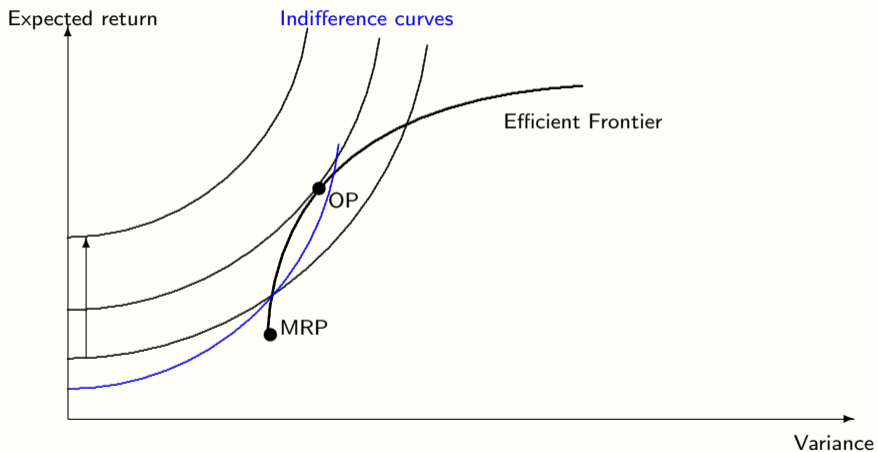
# Determination of the optimal choice



# Determination of the optimal choice

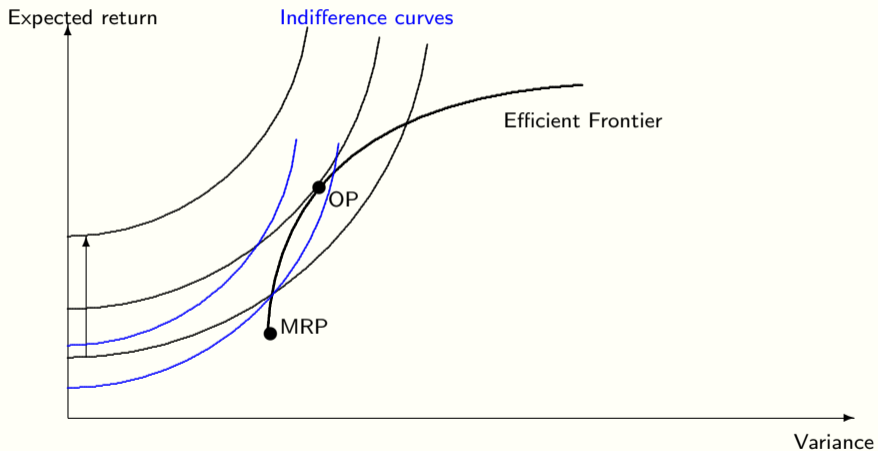


# Determination of the optimal choice

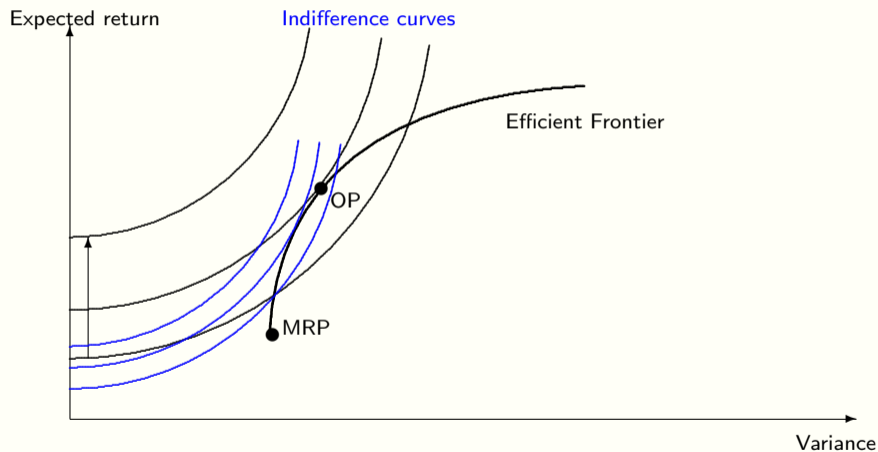




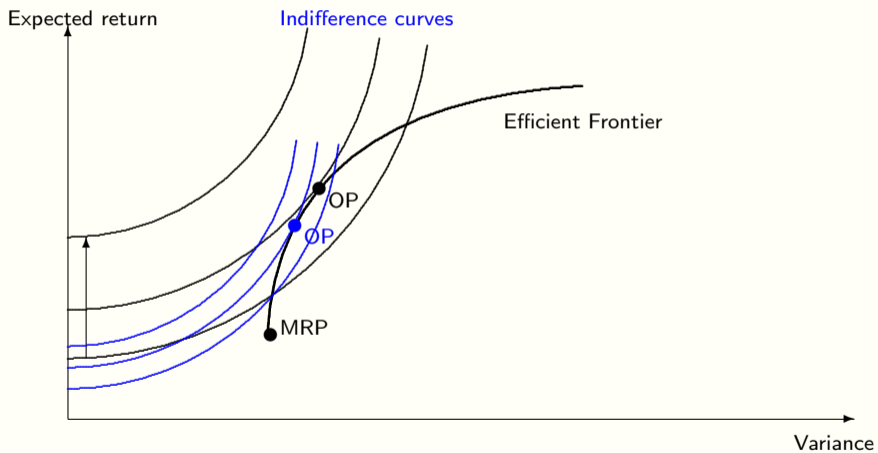
# Determination of the optimal choice



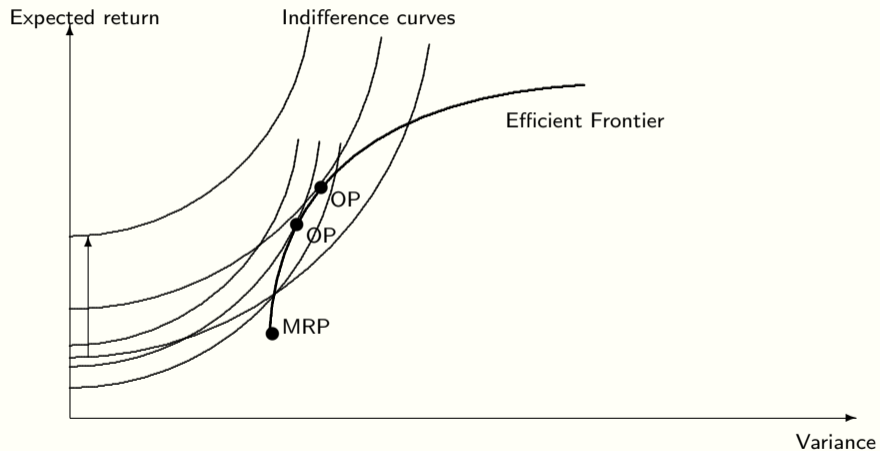
# Determination of the optimal choice



# Determination of the optimal choice



# Determination of the optimal choice



# Properties of the optimal portfolio

# Properties of the optimal portfolio

- ▶ The optimal choice (portfolio) is located where the indifference curve is **tangential** to the efficient frontier

# Properties of the optimal portfolio

- ▶ The optimal choice (portfolio) is located where the indifference curve is tangential to the efficient frontier
- ▶ A higher risk aversion **reduces** the risk of the optimal portfolio

# Properties of the optimal portfolio

- ▶ The optimal choice (portfolio) is located where the indifference curve is tangential to the efficient frontier
- ▶ A higher risk aversion reduces the risk of the optimal portfolio
- ▶ The more risk averse an individual is, the closer the optimal portfolio moves to the **minimum risk portfolio**



# Properties of the optimal portfolio

- ▶ The optimal choice (portfolio) is located where the indifference curve is tangential to the efficient frontier
- ▶ A higher risk aversion reduces the risk of the optimal portfolio
- ▶ The more risk averse an individual is, the closer the optimal portfolio moves to the minimum risk portfolio



Copyright © by Andreas Krause

Picture credits:

Cover: Premier regard, Public domain, via Wikimedia Commons, [https://commons.wikimedia.org/wiki/File:DALL-E\\_-\\_Financial\\_markets\\_\(1\).jpg](https://commons.wikimedia.org/wiki/File:DALL-E_-_Financial_markets_(1).jpg)

Back: Rhododendrites, CC BY-SA 4.0 <https://creativecommons.org/licenses/by-sa/4.0>, via Wikimedia Commons, [https://upload.wikimedia.org/wikipedia/commons/0/04/Manhattan\\_at\\_night\\_south\\_of\\_Rockefeller\\_Center\\_panorama\\_\(11263p\).jpg](https://upload.wikimedia.org/wikipedia/commons/0/04/Manhattan_at_night_south_of_Rockefeller_Center_panorama_(11263p).jpg)

Andreas Krause  
Department of Economics  
University of Bath  
Claverton Down  
Bath BA2 7AY  
United Kingdom

E-mail: [mnsak@bath.ac.uk](mailto:mnsak@bath.ac.uk)