



Aalto-yliopisto  
Perustieteiden  
korkeakoulu

# Portfoliopäätöksenteon vinoumat (valmiin työn esittely)

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Työn saa tallentaa ja julkistaa Aalto-yliopiston avoimilla verkkosivuilla. Muilta osin kaikki oikeudet pidätetään.

# Portfoliopäätöksenteko

- Pyrkimys: mahdollisimman hyvä toimenpidekokoelma (=portfolio) annettujen arvokriteerien ja rajoitusten puitteissa
- Ongelmat usein monitulkintaisia ja ratkaisun määrittely monikriteeristä
- Esimerkkeinä urheilujoukkueiden pelikokoonpanot

# Päätöksenteon vinoumat

- Voidaan jakaa kahteen osaan
  - (Fasolo, Morton ja Winterfeldt, 2011)
- Kognitiivis-motivatoriset vinoumat
  - Johtuvat ihmisen ajatteluun ja havaitsemiseen liittyvistä ominaisuuksista
- Organisatoriset vinoumat
  - Johtuvat sosiaalisesta paineesta, oman edun ajamisesta tai organisaation dynamiikasta
- Keskityn tässä kandidaatintyössä kognitiivis-motivatorisiin vinoumiin ympäristöpäätöksenteon portfoliotehtävässä

# Kognitiivis-motivationaleisia vinoumia

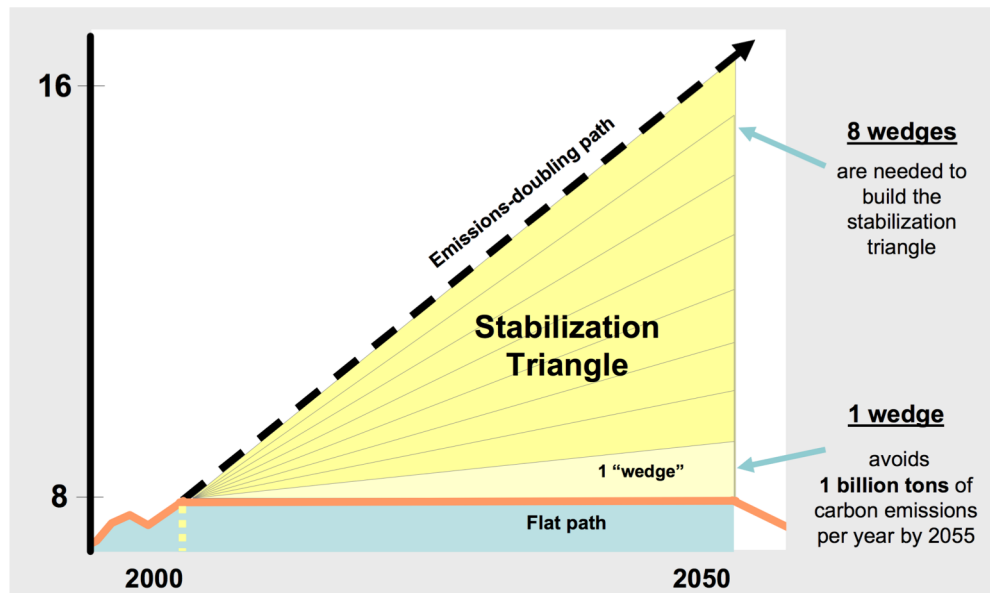
- Tappioiden välttely (loss aversion)
- Ankkuroituminen (anchoring)
- Kapeakatseisuus (narrow thinking)
- Näkökulmien avulla eliminointi (elimination by aspects)
- Omistusvaikutus (endowment effect)

+ lukuisia lisää

(Montibeller ja Winterfeldt, 2015)

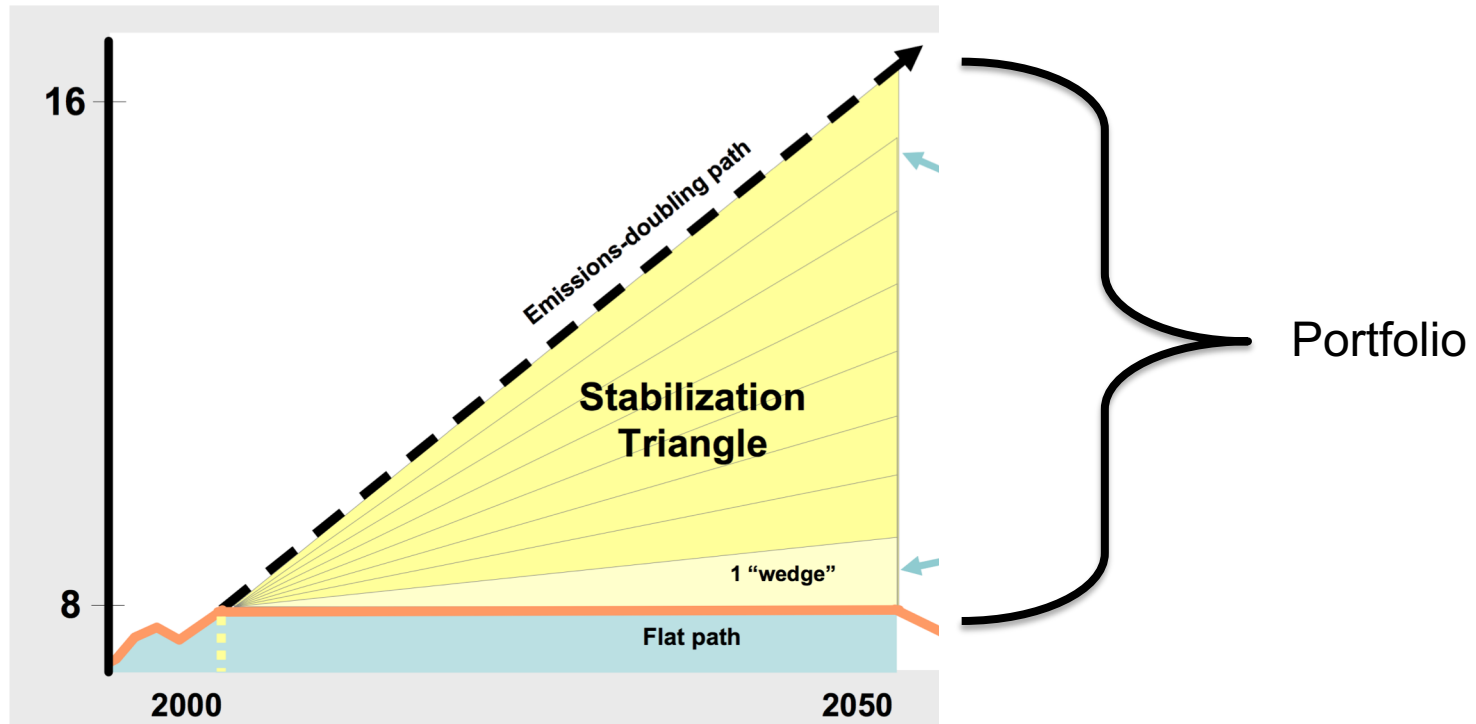
# Kiilapeli kasvihuonekaasujen vähentämiseksi

- 8 toimenpidettä riittää päästöjen stabiloimiseksi



<http://cmi.princeton.edu/wedges/>

# Portfoliotehtävä: Valitse 8 toimenpidettä



<http://cmi.princeton.edu/wedges/>

# Toimenpidevaihtoehdot

Strategy	Sector	Description	1 wedge could come from...	Cost	Challenges
1. Efficiency – Transport		Increase automobile fuel efficiency (2 billion cars projected in 2050)	... doubling the efficiency of all world's cars from 30 to 60 mpg	\$	Car size & power
2. Conservation - Transport		Reduce miles traveled by passenger and/or freight vehicles	... cutting miles traveled by all passenger vehicles in half	\$	Increased public transport, urban design
3. Efficiency - Buildings		Increase insulation, furnace and lighting efficiency	... using best available technology in all new and existing buildings	\$	House size, consumer demand for appliances
4. Efficiency – Electricity		Increase efficiency of power generation	... raising plant efficiency from 40% to 60%	\$	Increased plant costs
5. CCS Electricity		90% of CO <sub>2</sub> from fossil fuel power plants captured, then stored underground (800 large coal plants or 1600 natural gas plants)	... injecting a volume of CO <sub>2</sub> every year equal to the volume of oil extracted	\$\$	Possibility of CO <sub>2</sub> leakage
6. CCS Hydrogen		Hydrogen fuel from fossil sources with CCS displaces hydrocarbon fuels	... producing hydrogen at 10 times the current rate	\$\$\$	New infrastructure needed, hydrogen safety issues
7. CCS Synfuels		Capture and store CO <sub>2</sub> emitted during synfuels production from coal	... using CCS at 180 large synfuels plants	\$\$	Emissions still only break even with gasoline
8. Fuel Switching – Electricity		Replacing coal-burning electric plants with natural gas plants (1400 1 GW coal plants)	... using an amount of natural gas equal to that used for all purposes today	\$	Natural gas availability
9. Nuclear Electricity		Displace coal-burning electric plants with nuclear plants (Add double current capacity)	... ~3 times the effort France put into expanding nuclear power in the 1980's, sustained for 50 years	\$\$	Weapons proliferation, nuclear waste, local opposition
10. Wind Electricity		Wind displaces coal-based electricity (10 x current capacity)	... using area equal to ~3% of U.S. land area for wind farms	\$\$	Not In My Back Yard (NIMBY)
11. Solar Electricity		Solar PV displaces coal-based electricity (100 x current capacity)	.. using the equivalent of a 100 x 200 km PV array	\$\$\$	PV cell materials
12. Wind Hydrogen		Produce hydrogen with wind electricity	... powering half the world's cars predicted for 2050 with hydrogen	\$\$\$	NIMBY, Hydrogen infrastructure, safety
13. Biofuels		Biomass fuels from plantations replace petroleum fuels	... scaling up world ethanol production by a factor of 12	\$\$	Biodiversity, competing land use
14. Forest Storage		Carbon stored in new forests	... halting deforestation in 50 years	\$	Biodiversity, competing land use
15. Soil Storage		Farming techniques increase carbon retention or storage in soils	... practicing carbon management on all the world's agricultural soils	\$	Reversed if land is deep-plowed later








# Tutkimustehtävä – [carbcut.aalto.fi](http://carbcut.aalto.fi)

- Interaktiivinen verkkototeutus
- Portfolio muodostetaan kahdella eri tavalla
  - **Lisäten** (add) yksitellen koriin 8 haluttua vaihtoehtoa
  - **Karsien** (remove) vaihtoehtoja 15 mahdollisesta kunnes jää 8
- Menetelmien, sekä toimenpiteiden järjestykset satunnaistettu
- Tutkimuskysymys:
  - Syntykö eroja
  - Mikä vinouma voi selittää?











# Interaktiivinen koe verkossa

Strategies not included in the basket  
Click on strategy to add it into the basket.

3. Efficiency - Buildings		Increase insulation, furnace and lighting efficiency
4. Efficiency - Electricity		Increase efficiency of power generation
5. CCS Electricity		90% of CO <sub>2</sub> from fossil fuel power plants captured, then stored underground (800 large coal plants or 1600 natural gas plants)
7. CCS Synfuels		Capture and store CO <sub>2</sub> emitted during synfuels production from coal
8. Fuel Switching - Electricity		Replacing coal-burning electric plants with natural gas plants (1400 1 GW coal plants)
12. Wind Hydrogen		Produce hydrogen with wind electricity
15. Soil Storage		Farming techniques increase carbon retention or storage in soils

Your basket of strategies

Click on strategy to remove it from the basket.





10. Wind Electricity		Wind displaces coal-based electricity (10 x current capacity)
14. Forest Storage		Carbon stored in new forests
11. Solar Electricity		Solar PV displaces coal-based electricity (100 x current capacity)
1. Efficiency - Transport		Increase automobile fuel efficiency (2 billion cars projected in 2050)
2. Conservation - Transport		Reduce miles traveled by passenger and/or freight vehicles
9. Nuclear Electricity		Displace coal-burning electric plants with nuclear plants (Add double current capacity)
13. Biofuels		Biomass fuels from plantations replace petroleum fuels
6. CCS Hydrogen		Hydrogen fuel from fossil sources with CCS displaces hydrocarbon fuels

<http://carbcut.aalto.fi>

# Työskentely kokeessa


## Strategies not included in the basket

Click on strategy to add it into the basket.

<b>6. CCS Hydrogen</b>		Hydrogen fuel from fossil sources with CCS displaces hydrocarbon fuels
<b>12. Wind Hydrogen</b>		Produce hydrogen with wind electricity
<b>3. Efficiency - Buildings</b>		Increase insulation, furnace and lighting efficiency
<b>2. Conservation - Transport</b>		Reduce miles traveled by passenger and/or freight vehicles

## Your basket of strategies

Click on strategy to remove it from the basket.

<b>15. Soil Storage</b>		Farming techniques increase carbon retention or storage in soils
<b>... practicing carbon management on all the world's agricultural soils</b>	\$	Reversed if land is deep-plowed later
Do not include in the basket <input type="button" value="Confirm"/> <input type="button" value="Cancel"/>		

<http://carbcut.aalto.fi>

# Koehenkilöt

- Koe osa kurssisuoritusta, osalle palkkiona lisäpisteitä. Tutkijat vapaaehtoisia
- Suurin osa (n=163) ilmoitti korkeimmaksi tämänhetkiseksi tutkinnokseen ylioppilastutkinnon

Koulutustausta	n
kauppatieteet	142
tekniikan ala	129

Sukupuoli	n
naisia	73
miehiä	214

# Koehenkilöiden rekrytointi

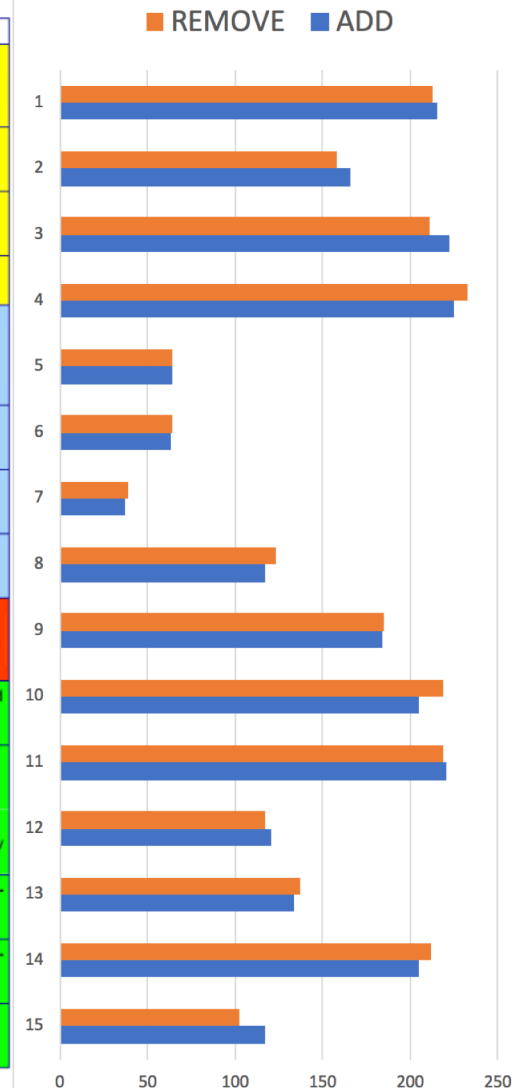
Ryhmä	n
Sov.mat. tietokonetyöt	47
Talousmatematiikka (BIZ)	116
Optimoinnin perusteet	86
BOR-konferenssi EAWAG	28
Muut	14
Yhteensä	291

# Valittujen toimenpiteiden jakauma

Strategy	Sector	Description	1 wedge could come from...	Cost	Challenges	ADD	REMOVE	ero	
1. Efficiency – Transport		Increase automobile fuel efficiency (2 billion cars projected in 2050)	... doubling the efficiency of all world's cars from 30 to 60 mpg	\$	Car size & power	1	215	213	2
2. Conservation - Transport		Reduce miles traveled by passenger and/or freight vehicles	... cutting miles traveled by all passenger vehicles in half	\$	Increased public transport, urban design	2	166	158	8
3. Efficiency - Buildings		Increase insulation, furnace and lighting efficiency	... using best available technology in all new and existing buildings	\$	House size, consumer demand for appliances	3	<b>222</b>	<b>211</b>	<b>11</b>
4. Efficiency – Electricity		Increase efficiency of power generation	... raising plant efficiency from 40% to 60%	\$	Increased plant costs	4	225	233	-8
5. CCS Electricity		90% of CO <sub>2</sub> from fossil fuel power plants captured, then stored underground (800 large coal plants or 1600 natural gas plants)	... injecting a volume of CO <sub>2</sub> every year equal to the volume of oil extracted	\$\$	Possibility of CO <sub>2</sub> leakage	5	64	64	0
6. CCS Hydrogen		Hydrogen fuel from fossil sources with CCS displaces hydrocarbon fuels	... producing hydrogen at 10 times the current rate	\$\$\$	New infrastructure needed, hydrogen safety issues	6	63	64	-1
7. CCS Synfuels		Capture and store CO <sub>2</sub> emitted during synfuels production from coal	... using CCS at 180 large synfuels plants	\$\$	Emissions still only break even with gasoline	7	37	39	-2
8. Fuel Switching – Electricity		Replacing coal-burning electric plants with natural gas plants (1400 1 GW coal plants)	... using an amount of natural gas equal to that used for all purposes today	\$	Natural gas availability	8	117	123	-6
9. Nuclear Electricity		Displace coal-burning electric plants with nuclear plants (Add double current capacity)	... ~3 times the effort France put into expanding nuclear power in the 1980's, sustained for 50 years	\$\$	Weapons proliferation, nuclear waste, local opposition	9	184	185	-1
10. Wind Electricity		Wind displaces coal-based electricity (10 x current capacity)	... using area equal to ~3% of U.S. land area for wind farms	\$\$	Not In My Back Yard (NIMBY)	10	<b>205</b>	<b>219</b>	<b>-14</b>
11. Solar Electricity		Solar PV displaces coal-based electricity (100 x current capacity)	.. using the equivalent of a 100 x 200 km PV array	\$\$\$	PV cell materials	11	221	219	2
12. Wind Hydrogen		Produce hydrogen with wind electricity	... powering half the world's cars predicted for 2050 with hydrogen	\$\$\$	NIMBY, Hydrogen infrastructure, safety	12	121	117	4
13. Biofuels		Biomass fuels from plantations replace petroleum fuels	... scaling up world ethanol production by a factor of 12	\$\$	Biodiversity, competing land use	13	134	137	-3
14. Forest Storage		Carbon stored in new forests	... halting deforestation in 50 years	\$	Biodiversity, competing land use	14	205	212	-7
15. Soil Storage		Farming techniques increase carbon retention or storage in soils	... practicing carbon management on all the world's agricultural soils	\$	Reversed if land is deep-plowed later	15	<b>117</b>	<b>102</b>	<b>15</b>

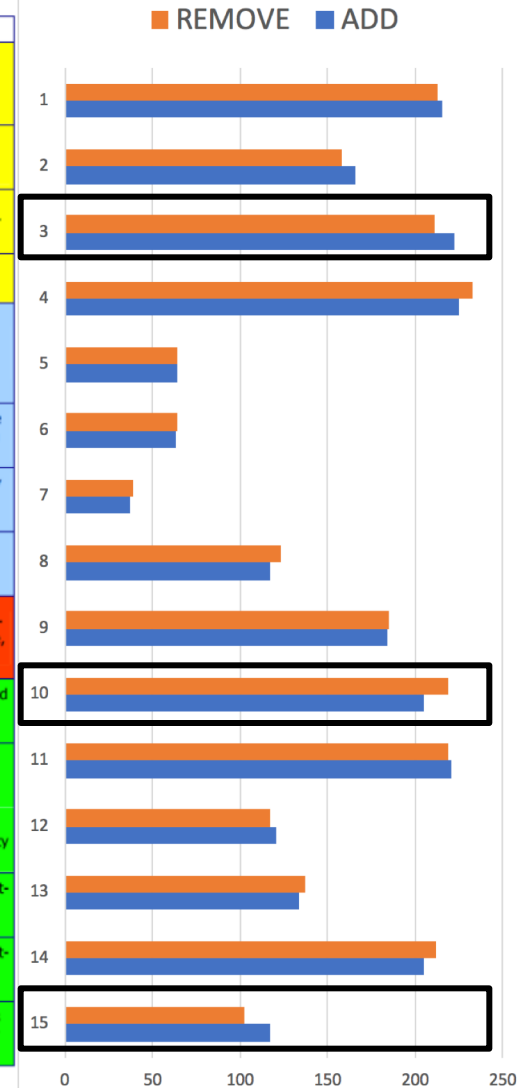
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# Portfolioiden erot

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3. Efficiency - Buildings		Increase insulation, furnace and lighting efficiency	... using best available technology in all new and existing buildings	\$	House size, consumer demand for appliances
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# Tulokset

	ADD	REMOVE	P-arvo
Kesto (s)	159	186	0.0067
Vaikeus (1 - 5)	2.54	2.91	<0.0001
Paremmaksi koettu lopputulos	62	54	

Menetelmien väliset erot	(n=291)
Samoja toimenpiteitä (max 8)	6.98
Täysin samat portfoliot	108

Samat toimenpiteet	ADD - REMOVE	REMOVE – ADD
6.98	7.09	6.89

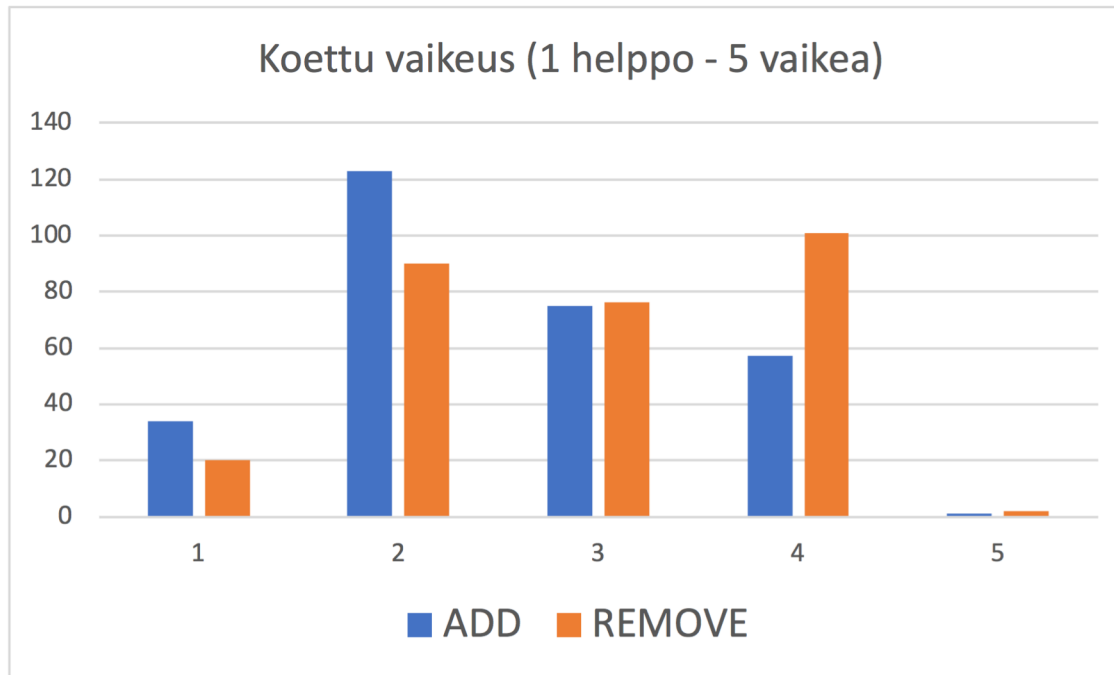


# Polkuriippuvuus

Aika (s)	ADD	REMOVE
Kun tehty ensimmäisenä	213.2	244.9
Kun tehty toisena	113.9	114.1

Vaikeus (1-5)	ADD	REMOVE
Kun tehty ensimmäisenä	2.57	3.16
Kun tehty toisena	2.51	2.58

# Menetelmien välinen vaikeusero



Aika (s)	ADD	REMOVE
ADD helpompi	130.5	215.6
REMOVE helpompi	189.8	164.7

# Korjailu: Toimenpiteiden takaisinsiirto

Vaikeus (1-5)	ADD	REMOVE
Ei korjailua	261	253
Tehtävän aikana	20	18
Tarkasteluvaiheessa	12	22

# Tulokset

- Ei merkittävää eroa lopullisissa portfolioissa
  - Koulutustaustalla ei merkittävää vaikutusta
- **Remove-menetelmä koetaan keskimäärin vaikeampana ja siihen käytetään keskimäärin enemmän aikaa**

# Mahdollisia selityksiä

- Omistusvaikutus (endowment effect)
    - Ei haluta luopua ”omistetusta” toimenpiteestä
  - Tappioiden välttely (loss aversion)
    - Ei haluta menettää toimenpiteen tuomia hyötyjä,
  - Epämääräisyyden välttely
    - ADD-menetelmällä nähdään koko ajan, mitä on valittu
- + Muita selityksiä?

# Lähteet

- Fasolo, B., Morton, A. and Winterfeldt, D. Von (2011) 'Portfolio Decision Analysis', 162, pp. 149–165.
- Hotinski, R. (2007) 'Stabilization wedges: a concept game', *Princeton Environmental Institute*, (September 2011), p. 16.
- Hämäläinen, Raimo P. 'Behavioural issues in environmental modelling–The missing perspective.' *Environmental Modelling & Software* 73 (2015): 244-253.
- Lahtinen, Tuomas J., Joseph HA Guillaume, and Raimo P. Hämäläinen. 'Why pay attention to paths in the practice of environmental modelling?.' *Environmental Modelling & Software* 92 (2017): 74-81.
- Lahtinen, Tuomas J., Raimo P. Hämäläinen, and Juuso Liesiö. 'Portfolio decision analysis methods in environmental decision making.' *Environmental Modelling & Software* 94 (2017): 73-86.
- Montibeller, G. and von Winterfeldt, D. (2015) 'Cognitive and Motivational Biases in Decision and Risk Analysis', *Risk Analysis*, 35(7), pp. 1230–1251.