

**Doctoral course**  
**Climate Economics for Engineers**

**Introduction to cost-benefit analysis**  
**(CBA)**

Prof. Philippe Thalmann

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# Table of Content

- CBA compared to other collective decision rules
- History of CBA
- Theoretical foundations
- Limitations of CBA

# Alternative public decision rules

1. Qualitative assessment: list positive and negative effects; the longest list carries the decision (cf. environmental impact assessment)
2. Multi-criteria decision analysis: define indicators and grading rules; decide on weights; calculate weighted total grade; highest grade carries the decision
3. Financial assessment: if (sum of revenues) > (sum of costs), carry out
4. CBA: extension of financial assessment
5. Social welfare assessment: Social Welfare =  $W[u_1(x_1), u_2(x_2), \dots, u_N(x_N)]$

# CBA goes beyond financial analysis

- **Financial analysis**

- Question: is a decision conducive to profit (incomes > expenses)?
- Basis: incomes and expenses, as stated in the firm's income statement

- **CBA** (also known as public economic analysis)

- Question: does a project/service/program improve the welfare of the community?
  - ⇒ Are the **social benefits** > the **social costs**?
  - ⇒ Which project to choose with limited funds?
  - ⇒ Incomes > costs is (almost) irrelevant
- Basis: social benefits and social costs

**Financial  
analysis**

*Firms*

**CBA**  
(public economic  
analysis)

*The entire  
community*

# CBA principles

Justification	economic scarcity, limited <u>real</u> resources $\Rightarrow$ efficient use of resources has major impact on the welfare and living standards of citizens
Time	<i>ex ante</i> or <i>ex post</i> analysis
Purpose	evaluation of projects / services / programs
Concept	comparison of benefits (advantages) and costs (disadvantages)
Quantification	monetary units
Rule	implement project if its benefits exceed its costs

# Informal CBA

The New York Times

The Coronavirus Outbreak | **LIVE** Latest Updates | Maps and Tracker | Markets | Stimulus Checks | What You Can Do | Newsletter

## *Shutdown Spotlights Economic Cost of Saving Lives*

President Trump and others have asked if halting normal life and commerce to fight the coronavirus is worth the cost. Here's how economists figure it.

<https://nyti.ms/3drPKLV>



By Eduardo Porter and Jim Tankersley

Published March 24, 2020 Updated April 13, 2020



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Can we measure the cost of hundreds of thousands of dead?

President Trump and leading business figures are increasingly questioning the wisdom of a prolonged shutdown of the American [economy](#) — already putting millions out of work — to curb the spread of the [coronavirus](#) pandemic.

“Our people want to return to work,” Mr. Trump [declared Tuesday on Twitter](#), adding, “THE CURE CANNOT BE WORSE (by far) THAN THE PROBLEM!”

In essence, he was raising an issue that economists have long grappled with: How can a society assess the trade-off between economic well-being and health?

# CBA can be cruel

## Trois morts sur un passage trop cher à moderniser

**NIDWALD.** Un minibus de touristes a été percuté par un train hier à Wolfenschiessen. La tragédie était évitable.

En 2013, six personnes ont perdu la vie sur des passages à niveau. Et treize ont été gravement blessées, selon les statistiques de l'Office fédéral des transports (OFT). Hier, une collision entre un train de la Zentralbahn et un minibus a fait de nouvelles victimes (lire ci-dessous).

La problématique inquiète à ce point la Confédération qu'elle a exigé des entreprises de chemin de fer qu'elles sécurisent les mille passages encore démunis de barrières et/ou de feux d'ici à la fin de l'année. Et celui où s'est joué le drame d'hier aurait pu l'être. En 2009 déjà, le Parlement nidwaldien avait en effet accordé un crédit de 4,7 millions à la Zentralbahn. Mais le coût des travaux a été réestimé,



Le véhicule a été happé par le convoi. Un accident avait déjà eu lieu au même endroit le 21 juillet. -KEystone

passant à 17,8 millions, dont 9 à la charge des autorités. Trop cher pour le Grand Conseil, qui a exigé du gouvernement qu'il fasse diminuer la facture.

Un sujet que n'a pas commenté la conseillère d'Etat Karin Kayser, cheffe du Département de la sécurité. «Nous faisons tout pour que ces mises aux

normes se fassent au plus vite et nous accompagnons les entreprises de transport dans ce but», assure pour sa part le porte-parole de l'OFT. Dans ce

It was decided that making this railway crossing safe was too costly



# HISTORY OF COST-BENEFIT ANALYSIS



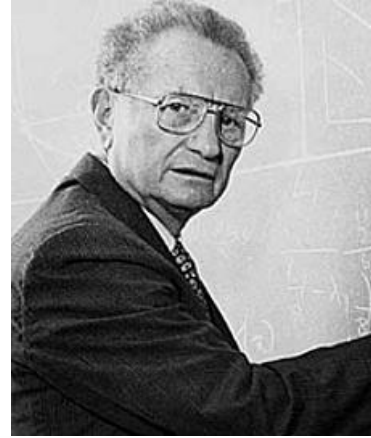
# History of CBA



Jules Dupuit, engineer, F,  
Ecole des Ponts et  
Chaussées, 1804-1866

- The idea of this economic accounting was originally that of a French engineer: Jules Dupuit, "La mesure de l'utilité des travaux publics", *Annales des Ponts et Chaussées* (1844), 2<sup>ème</sup> série, 2<sup>e</sup> sem., 332-375 [transl.: "On the Measurement of the Utility of Public Works", *International Economic Papers* (1952), 2: 83-110]
- At the turn of the century, the British economist Alfred Marshall formulated some of the concepts that are at the foundation of CBA
- The practical development of CBA came as a result of the impetus provided by the US Federal Navigation Act of 1936. This Act required that the U.S. Corps of Engineers carry out projects for the improvement of the waterway system when the total benefits of a project to whomever they accrue exceeded the costs of that project. The Corps had to create systematic methods for measuring benefits and costs. The engineers of the Corps did this without much, if any, assistance from the economics profession

# History of CBA (continued)



Paul Samuelson,  
economist, USA,  
MIT, 1915-2009

- It wasn't until about twenty years later, in the 1950's, that economists tried to provide a rigorous and consistent set of methods for measuring benefits and costs and for deciding whether undertaking a project is in the public interest (welfare economics)
- Europe in the 50s and 60s
- Many uses in the field of defense in USA during Cold War (1949-91)
- Experimenting with «Planning Programming Budget System» (PPBS, including CBA) in Robert McNamara's Defense Department (1961-68)
- Extension to all departments, even after the abandonment of the PPBS by Nixon (1971)
- Reinforced role in 1993 thanks to the EPA
- Copenhagen Consensus (2004, Bjørn Lomborg)



# THEORETICAL FOUNDATIONS

# Decision rules

Payoff matrix for a project:

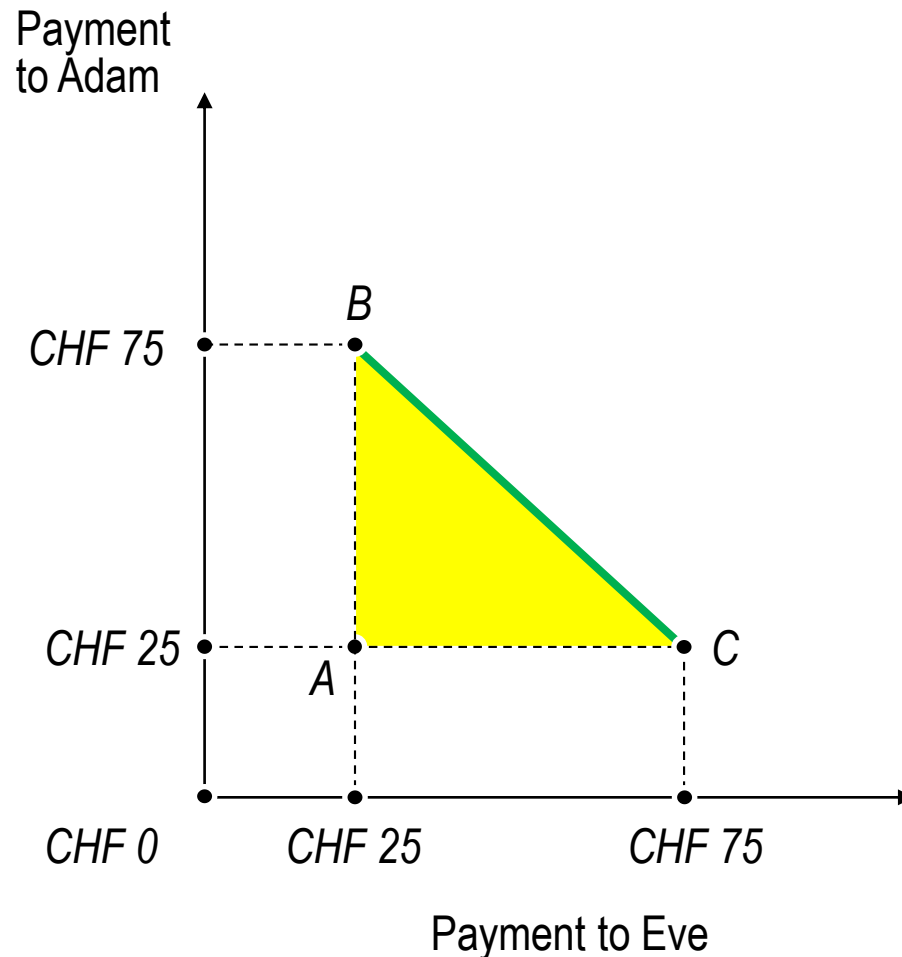
Individual	Payoff (CHF equivalent)
A	10
B	8
C	0
D	-1
E	-3
F	-5

Should this project be undertaken?

# Pareto efficiency

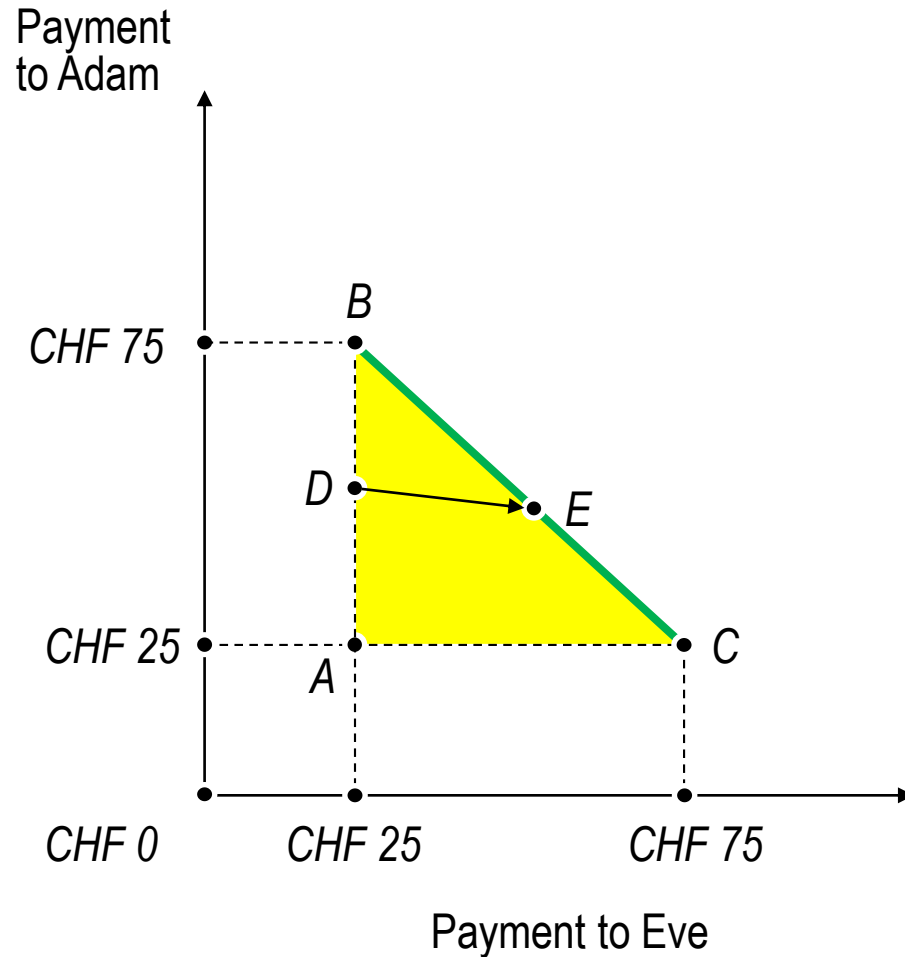
- An allocation of goods among a group or persons is **Pareto efficient** if no alternative allocation can make at least one person better off without making at least one person worse off
- An allocation of goods is **Pareto inefficient** if an alternative allocation can be found that would make at least one person better off without making anyone worse off
- A **Pareto improvement** is a reallocation of goods that makes at least one person better off and none worse off
- One would have to be malevolent not to want to attain Pareto efficiency
- Why forgo a Pareto improvement, i.e. gains to some persons without losses to anyone?

# Pareto frontier for splitting CHF 100 between Adam and Eve



- *A*: initial distribution (by assumption) – status quo point if the two individuals cannot agree on how to split the money: each gets 25
- Triangle *ABC*: Pareto improvements relative to status quo
- Segment *BC* : **Pareto frontier**, set of all Pareto efficient allocations
- Triangle *ABC* without frontier: Pareto inefficient allocations (not all of the money is used)

## Is this move acceptable or not?



- *D*: Adam gets 50, Eve 25; 25 are unused
- *E*: Adam gets 45, Eve 55; all the money is used
- Adam is worse off with *E* than with *D*, so  $D \rightarrow E$  is **not** a Pareto improvement

# Decision rule for CBA

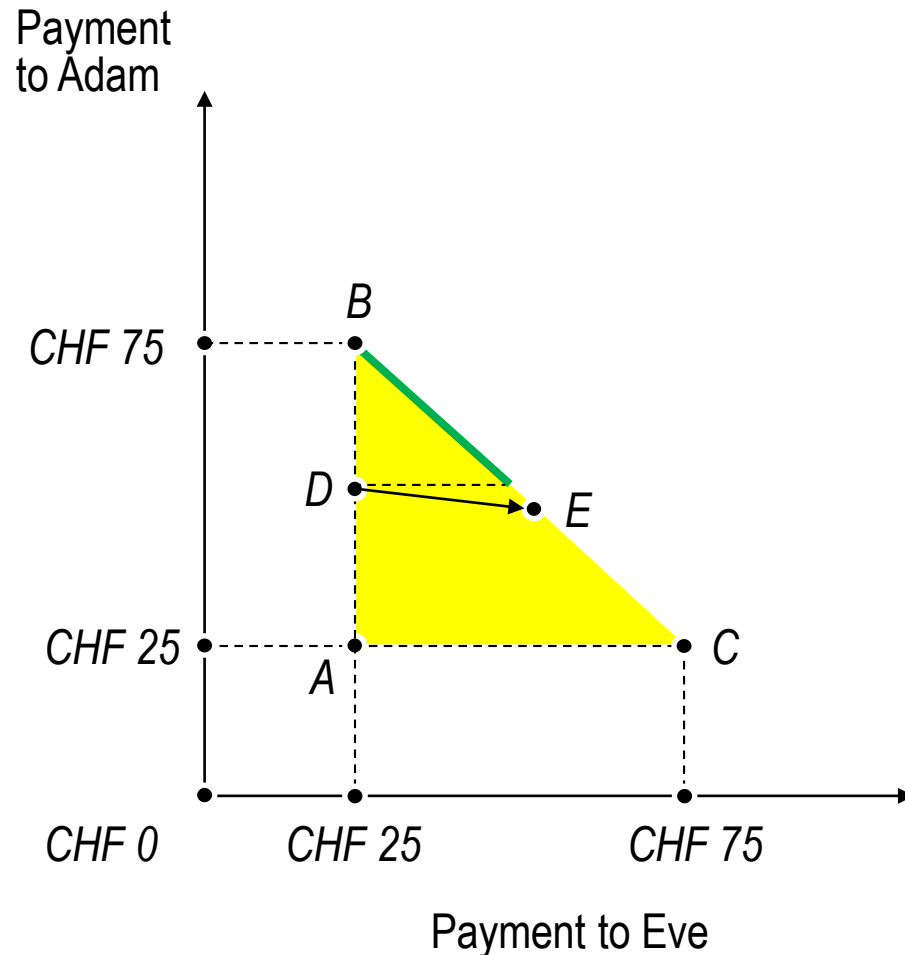


Nicholas Kaldor,  
economist, H/GB,  
LSE, 1908-1986

- CBA utilizes a decision rule inspired by but different from the Pareto efficiency rule
- Rule based on the Hicks-Kaldor Criterion (HKC): A policy should be adopted if and only if those who will gain could fully compensate those who will lose and still be better off
- It is also called 'potential Pareto efficiency rule' or 'net benefit criterion'
- Adopt policies that yield an excess of benefits over costs
- Many more policies are feasible under the HKC than under the Pareto efficiency rule
- Why not carry out the compensations? Because problematic and costly



## Possible compensation



- *D*: Adam gets 50, Eve 25; 25 are unused
- *E*: Adam gets 45, Eve 55; all the money is used
- From *E*, Eve could give Adam any amount between  $5+\varepsilon$  and  $30-\varepsilon$  and both would be better off than at *D*
- Adam would have at least  $45+5+\varepsilon = 50+\varepsilon$  and Eve would be left with at least  $55-(30-\varepsilon) = 25+\varepsilon$  (a point on green segment)

# Majority vote with transfers

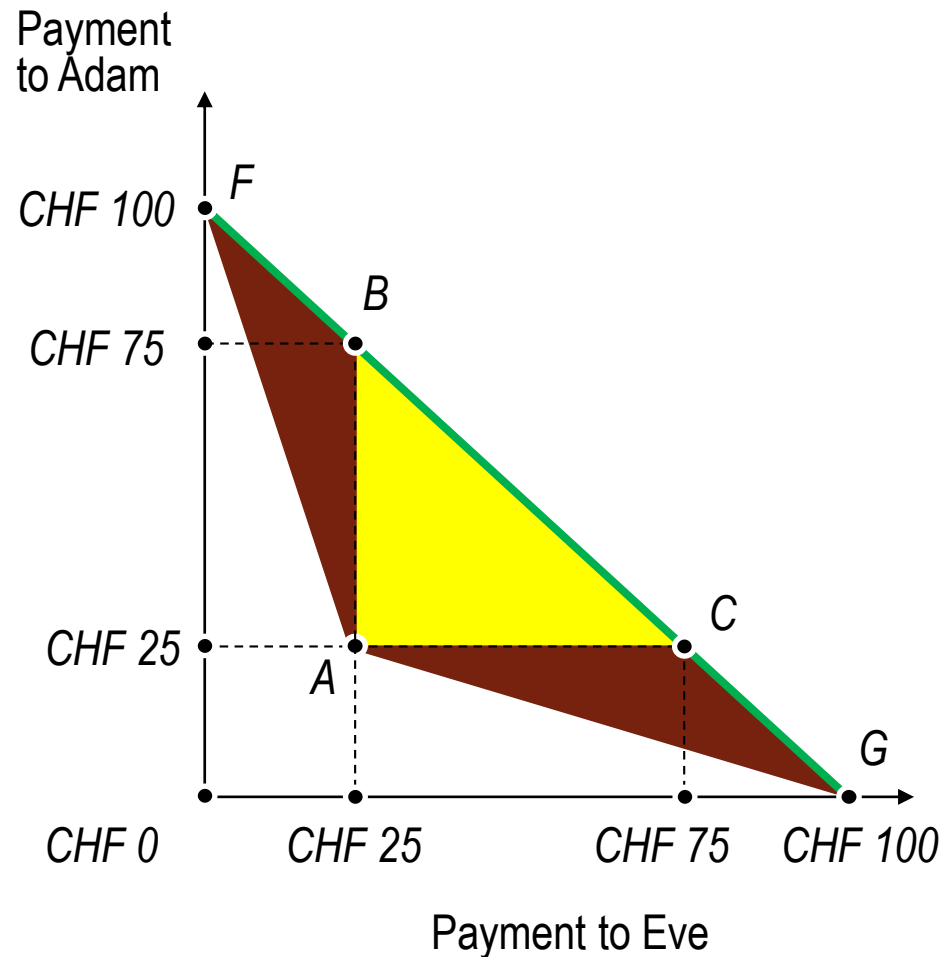
Same project as above

A pays 6 to F; B pays 4 to E and 1 to D

Individual	Initial payoff	Payoff after transfer
A	10	4
B	8	3
C	0	0
D	-1	0
E	-3	1
F	-5	1

4 vote YES, 2 abstain  $\Rightarrow$  project approved !

# Potential Pareto Frontier for splitting CHF 100 between Adam and Eve



- Triangle *AFG* : Potentially Pareto improving allocations relative to status quo (A)
- Segment *FG* : **Potential Pareto Frontier** (no money lost)
- Triangle *AFG* without frontier: inefficient allocations relative to HKC criterion

Source : Boardman (2011, pp. 28-29 and 32)

# LIMITATIONS OF CBA

# Limitations of CBA

- Human-centered assessment
- Hedonics-based assessment
- Only ends matter ("the ends justify the means")
- All costs and benefits have to be expressed in monetary terms (merchandising of environmental and social goods and bads)
- Assessment based on willingness to pay or to accept (WTP, WTA) gives more weight to wealthier individuals
- Are people's WTP/WTA the appropriate guides?
- What are the WTP/WTA of future generations?
- No consideration of who bears the costs and who enjoys the benefits
- Technocratic public decision making

# Intrinsic value of a natural resource (deep ecology)

## Whanganui River gets the rights of a legal person

MICHAEL DALY

Last updated 06:35, March 16 2017

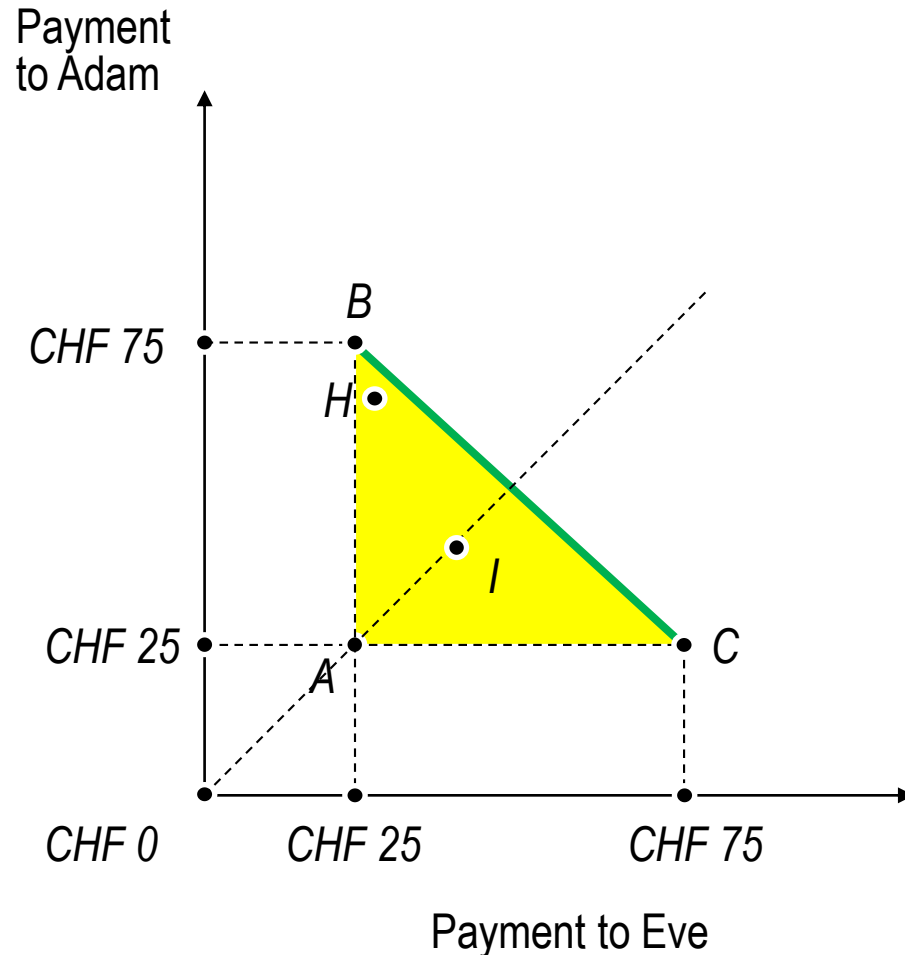


The Whanganui River [in New Zealand] has gained its own legal identity with all the corresponding rights, duties and liabilities of a legal person.

Te Awa Tupua (Whanganui River Claims Settlement) Bill, which passed its third reading in Parliament on Wednesday [15.03.2017], will establish a new legal framework for the river.

It recognised the river as an indivisible and living whole from the mountains to the sea.

# Efficiency vs equity



- *H*: Adam gets 70, Eve 27; 3 are unused
- *I*: Adam gets 35, Eve 35; 30 are unused
- *H* is more efficient in the sense of not wasting resource (money)
- *I* is more equitable
- $I \rightarrow H$  is an improvement in the sense of KHC (Adam could give Eve  $8+\varepsilon$  and both would be better off than at *I*)

# CONCLUSION



# Concluding comments

- Most economists agree that public policy debates on government spending projects are well-informed by careful cost-benefit analyses, which:
  - focus on true project costs and benefits
  - attempt to quantify them honestly and exhaustively
  - apply a consistent methodology to all potential projects
  - avoid the inclusion of bogus costs and benefits
- However, politicians may not approve to recourse to CBA, because
  - CBA focuses on “true” C&B, not on political ones
  - CBA focuses on C&B, irrespective of which lobby bears the costs or gets the benefits
  - once CBA results are known and a project was assessed as welfare decreasing, it is politically difficult to defend one’s (pet) project (technocracy has its advantages)

# REFERENCES

# References used to prepare these slides

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